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INCLINED SHAFT ROTARY ENGINES.

AT the close of the Inventions Exhibition it is not inappropriate, and may be acceptable to many of our readers, to pass in review a class of machinery upon which inventors have lavished a wealth of ingenuity. Rotary engines, as we have before remarked, are full of attraction to many people, and an examination of a selection of them cannot be without instruction to the engineer and to the inventor.

An important class of these motors, which has gained the admiration and puzzled the understanding of thousands, is based upon the mechanical gearing necessary to couple up revolving shafts converging toward each other. One method of connecting up such a pair of shafts is by what is known as the "Hooke joint," or, as it is sometimes called, the "universal joint." To introduce two of the most effective rotary engines, we have attached a sketch (Fig. 1) of this joint, as to properly understand them the movements that occur in the Hooke joint should be clear in the mind. In this mechanism, the inclined shafts are steadied in bearings secured to the foundation plate, D, the locus of convergence being at some intermediate point, C. At the ends of the shafts, which terminate at equal distances from this point, are formed cranks or arms, B B, A A, fitted with cylindrical holes, *a a*, *b b*, at their extremities, converging also to C. These holes are in such a position that those on one shaft are at opposite ends of the diameter of a circle whose center is at C, and those on the other shaft on a diameter perpendicular to the first. The four orifices thus provided are paired with pins connected to a plate, C, which in this case is circular.

The peculiarity in this connection, which makes it suitable for being set in action by a pressed fluid, is the reciprocating movement of the intermediate piece, C, which occurs when the mechanism is set in motion. Upon turning one of the shafts, this plate, to accommodate itself to the varying positions of the shafts, rocks backward and forward, at the same time revolving, at one time decreasing the space between a semicircular half on one side and the arms on one shaft, and increasing the similar space on the other side of the same shaft; similar actions occur also in the spaces toward the other shaft. The locus of the periphery of this rocking plate is a sphere whose center is at C. And therefore, if it be inclosed in a sphere of such a diameter that its surface may pair with the edge of the plate, and if the arms of the shafts be filled in by a plane touching against the plate across the diameter, *a a*, *b b*, the outer parts of these arms being so formed as to revolve in the same sphere, it will be seen that the spaces spoken of become closed in for every position of the mechanism, each space alternately expanding and contracting in volume. If, instead of turning a shaft and obtaining as a consequence the increase and decrease of the chambers, a pressed fluid be allowed to enter and increase the chambers and escape when they contract, then we have as a consequence the revolving movement of the shaft. Such is the action taking place in the Towers engine.

Another method of chambering may be followed. We notice that when this gear is in motion, the points, *a a*, describe circles toward the shaft, B, the planes of these circles being perpendicular to the arms of the shaft. Also the points, *b b*, make similar circles toward the shaft, A. Supposing, now, two cylinders are constructed, whose bases are secured flat on the arms of one shaft, B, and whose axes are circles coinciding with that in an arc of which *a a* move. Then, if we construct on the rocking plate circular arms, whose axes still coincide with the circle mentioned, and cause them to enter the cylinders on the shaft, making the connection steam-tight by pistons, we have chambers which enlarge or diminish as the arrangement is put in movement; similar cylinders being fitted on the arms of A, and paired with pistons at the ends of curved rods from *b b*. This is the mechanism of Fielding's engine.

A closer view of the Towers engine can be obtained from Fig. 2. The letters will serve to identify its construction with that of the Hooke joint. In this engine, the shafts, steadied in fixed bearings, are usually inclined at an angle of 135 deg. The arms at the ends of the shafts, A, B, are, broadly, segments of a sphere; the faces toward the rocking piece are flat, the back, where joining with the shaft, being flat also, for the greater convenience of fitting the steam entry and escape channels. These segments have to be made substantial in size, in order to fill in that part of the spherical casing through which the piston does not sweep, and so avoid large clearance spaces. The rocking piston is paired to the shaft arms, as in the universal joint, by the joints at *a a* and *b b*. The spaces on each side of the crank arms are kept distinct by rounding the inner edges of the segments and fitting them against similarly rounded projections on the piston. No sphere is shown in the sketch, in order to avoid confusion; from the form of the parts it can readily be seen how it envelops the whole, rocking piece and segments.

The distribution of steam at the proper times is carried out in very similar ways in the majority of this class of engine. In the engine under consideration, channels are cut in the faces of the segments as shown, thus entering fairly into each of the four chambers; the channels run back into the annular surface behind the segments, and are bounded by radial lines. This annular surface thus provided with ports—one to the space on one side the segment, and one to the space on the opposite side—revolves against faces constructed in cylindrical pieces, Z Z, shown drawn back in the sketch for the sake of clearness, but which are forced up against the revolving segments when the engine is ready for work. The large ports, E, are the exhaust ports, and are permanently connected to an exhaust pipe; the steam ports, S, are the smaller ones, and permanently connected to the supply pipe; and all are shown in their relative positions. At the present moment the space, *a* B, is exhausting; the chamber, a^1 B, is on the point of receiving steam; the chamber, *b* A, has just received a full supply, which is now cut off, and is on the point of being worked expansively; the chamber, b^1 A, is exhausting. The resultant effect of the action is such therefore as to produce a force on the rocking piece in the direction of the straight arrow, tending to turn the intermediate piece about the diameter, *a a*, and consequently so acting on the shaft, B, as to turn it in its bearings in the direction of the curved arrow. Further movement will result in the other openings admitting and exhausting the steam at the proper time, and keep up a continuous rotation in the same direction.

There are many internal joints in this device to keep steam-tight. The piston should be tight with the spherical chamber, the piston with the ends of the shaft segments, the sides of the shaft segments with the spherical chamber, and also with the valve face. One great feature here is that all the joints are surface joints, and therefore not nearly so untrustworthy as when only a bare line forms the contact. Some of these joints are treated only by excellent fitting, and by their comparative largeness of surface. The most important are fitted in the ordinary way, by letting in strips of phosphor bronze, pressed against the working face by springs. Such are the long lengths at the edges of the two segments where touching the rocking piece, and extending from joint to joint. Each quadrant of the piston periphery has slips of phosphor bronze included between two collars, and extending from joint to joint. At the joints steam-tightness is carried across by means of the horseshoe shaped pieces at *h*.

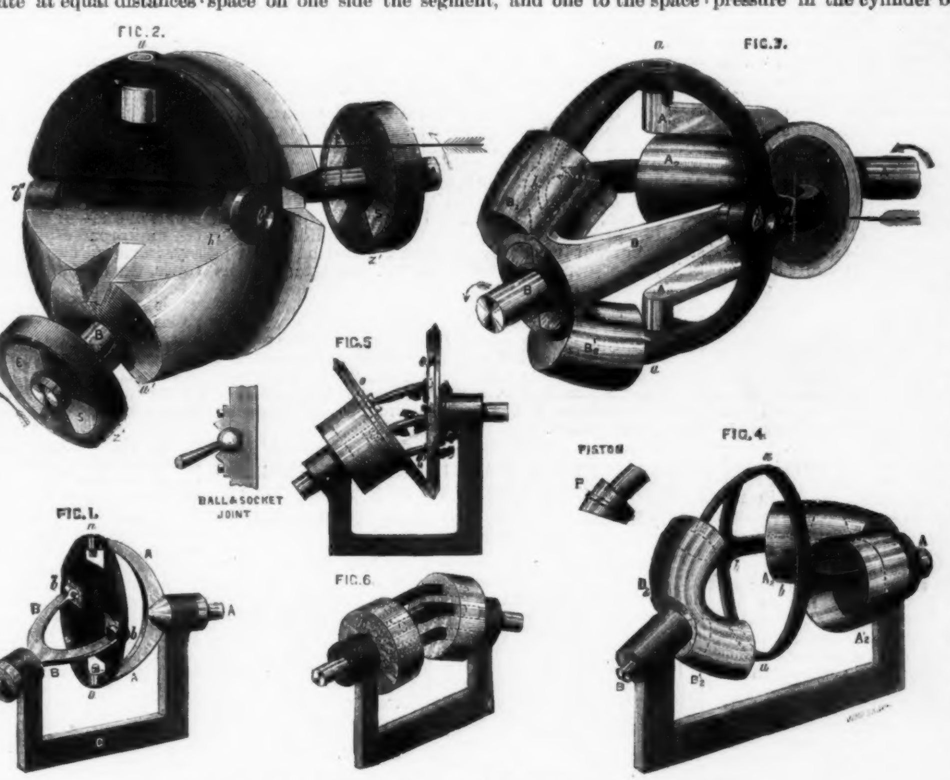
The expansion of steam in some of these engines is about two or two and a half times, but as in many cases compounding is resorted to, a much greater expansion, and consequent economy, may be obtained. For the class of high-speed engines these engines burn comparatively little coal, a simple non-condensing engine requiring about 5½ lb. or 6 lb. of coal per hour per effective horse-power. From the nature of the valve gear, such a high degree of expansion cannot be so effectively carried out as with the direct-acting engine. In the direct engine the operation of admission is promptly carried out, as when this occurs the valve is moving at its greatest speed while the piston is at its slowest. In the rotary engines in question, the valve face moves at the uniform speed of the shaft, and the admission is started in a gradual and comparatively leisurely manner. Thus, if a very early cut-off be attempted, the steam would not have attained its full pressure in the cylinder before being cut off. If these engines were fitted with separate valve gear, they would afford just the same facility for a higher degree of expansion as does the direct-acting engine running at the same speed. Such fittings, however, would interfere with the compactness and handiness of this class of engine, requiring more space, and demanding more care in its management.

A great feature in the Towers engine is the great amount of power developed in a small space. In the course of a revolution, each of the four chambers has been entered by the steam, and the moving piece in each chamber swept through one-quarter of the volume of the sphere. Thus the steam fills in the course of a revolution a volume equal to the volume of the whole sphere. The power estimated from this consideration is about 20 horse power, taking a mean pressure of 30 lb., a sphere of 10 in., and 500 revolutions per minute. The mean pressure would generally be higher—about in such a proportion as to give 20 effective horse power in the above case.

The Fielding engine can almost be followed from Figs. 3 and 4, and the letters indicating those parts identical with the fittings of the universal joint. The arms, B_1 B_1, of the shaft, B, are geared with the intermediate piece by means of the pin joints, *b b*; the arms, A_1 A_1, of the shaft, A, are similarly connected at *a a* with the same piece, the line, *a a*, being perpendicular to *b b*, both passing through the point toward which the shafts converge. In addition to this gearing, there are four curved arms rigidly attached to the intermediate piece in the neighborhood of the joints, *a a*, *b b*, and by means of pistons are paired to the short cylinders curving outward from each shaft. The cylinders are placed perpendicularly to the arms of the shaft on which they are secured, their axes being curved, as shown, to accommodate to the movement of the four pistons. Fig. 4 shows the positions of the pistons at one period.

When the whole mechanism is set in action, the four pistons move backward and forward in their respective cylinders, alternately enlarging and contracting the inclosed spaces. To allow of steam entering and escaping from these four spaces, valve gear very similar to that employed in the Towers engine is adopted. Channels run from the base of each cylinder, and appear as singular segments on a flat circular face as shown at V V. Pressed against this face and a similar face on the other shaft are two fixed port pieces like those described in the previous engine. The action of the steam on entering and exhausting is identical. At the position of the mechanism shown in the picture, steam is about to enter the cylinder, B^1_2; about to exhaust from B_2; is exhausting from A_2; and on the point of working expansively in A^1_2. Thus the effect is to produce a force in the direction of the straight arrow, turning the shaft, B, in the direction of the curved arrow, and the whole mechanism revolves. Each piston comes in at the proper time to keep up the rotation.

The joints to be kept steam-tight are the four pistons and the two valve faces. The valve faces are only fair



INCLINED SHAFT ROTARY ENGINES.

surfaces pressed against by the port blocks; a screw piece is provided and worked from the outside so as to set the blocks properly up against the revolving valve surfaces. These blocks are, of course, prevented from turning with the machinery. The pistons are of an awkward shape, being of double curvature; but it is still of such a character as to allow of the formation of wide surfaces of contact with the cylinders in which they reciprocate. A simple packing hoop is employed, as shown at P in Fig. 4, of the same construction as that used in many ordinary pistons. This hoop is set in between collars, and kept pressed outward by its own elasticity. The mechanism completed as described is covered in by a casing to protect the working parts from damage and dirt.

As far as the valve gear is concerned, about the same expansion of steam is provided for as in the Towers engine. A peculiarity of the Fielding is, however, that two of the cylinders on one of the shafts are made of larger diameter than those on the other, and the steam pipes so arranged as to work as a compound engine. By this means a considerable economy is obtained. The sketches given of this engine do not represent the actual detail of construction; it is intended to be only explanatory. The actual engine has its rocking piece recessed, so that in its movements it may work well clear of the cylinders toward which it rocks. In principle, the sketch and the engine are identical. For finished drawings of both the Towers engine and the Fielding, showing the construction of the parts in detail, readers are referred to previous numbers of this journal—10th August, 1883, and June, 1885.

The ordinary method of communicating motion from one revolving shaft to another inclined to it is by beveled cog wheels, but this movement has been so accompanied by suitable mechanism as to obtain the conditions necessary for producing the rotary motion of a shaft from the expansive energy of steam. A specimen of this character was exhibited, as represented in Fig. 5. Any two points situated in the faces of such revolving wheels, and which are opposite to each other, must evidently alternately approach and recede along the same straight line. They are nearest together when nearest to the point of contact of the wheels, and farthest apart after having moved through half a revolution, as at O O in the sketch. This motion being embodied in chambers and joints gives the enlargement and contraction of closed spaces as a result, which may be made use of for utilizing steam pressure.

In the sketch, four cylinders are seen to be constructed in the body of one of the cog wheels. The axes of these cylinders are parallel to the shaft, and are situated at equal radial distances from the axis of the shaft. These cylinders are paired with pistons which are secured to piston-rods, the opposite ends of these rods being jointed to the face of the opposite wheel. The points at which these ends of the piston-rods are attached are situated symmetrically to the cylinders in the other wheel. To accommodate this mechanism to the varying positions of the shaft, ball joints have to be introduced, as shown, both at the junction of the piston-rod and piston and piston-rod and wheel. By referring to the sketch, it will be seen that the space between the bottoms of the cylinders and the pistons becomes larger and smaller as the shafts are turned. Steam is admitted to these cylinders by channels constructed as in the Towers and Fielding, and produces the effect of forcing open the chambers and the revolution of the cog wheels. Comparing this contrivance for a moment with the spherical engine, we see the extraordinary compactness of the latter. It is almost identical in action, but in the former four separate single-acting cylinders are used, while in the spherical engine one chamber, in the form of a sphere, is so divided as to result in two double-acting compartments, which, as regards the working of the steam, are equivalent to four single-acting cylinders.

The joints to be made steam-tight in this engine are very simple. They are the pistons working in fair cylinders and the port face. The pistons are fitted as are those of the direct-acting engine. The difficulty is in the ball joint, which, although not a steam joint, is a kind of connection not possessing a reputation for durability and simplicity.

It is impossible to mention this last engine, or to dismiss the consideration of inclined-shaft engines, without another reference to the Cameron mechanical movement. By this arrangement the shafts would be connected up by knuckle pieces working into cylinders constructed in similar positions to the preceding (Fig. 5), but would require a second series symmetrically placed in the second shaft. This is shown in Fig. 6. The plane passing through both arms of each connecting piece is always parallel to the plane passing through the axes of the revolving shafts. As the mechanism is turned, the knuckle pieces pass in and out of their cylinders, as pointed out in the previous engine, the action being the same for both the sets of cylinders in the two wheels or shafts. If steam were admitted to these spaces as in the other engines, the whole system would be compelled to move, the shafts revolving. In turning this into a rotary engine, it might be necessary to gear up the shafts by beveled cogs, so as to relieve the working pieces upon which the steam would act from too much strain. The pairing of the sliding pieces with the cylinders is of such a nature as to require only the ordinary piston packing; but it should be noted that these pistons do not merely pass in and out of the cylinder, but turn in them at the same time. With this double movement set up, it would seem that greater wear must be looked for.—*The Engineer.*

A STEAM PUMP FOR LIQUID LEAD.

B. ROSING, of Friedrichshutte, Germany, has lately introduced an apparatus for pumping molten lead by steam pressure. Its special use is to facilitate the casting of lead into pigs, or its removal from one pot to another during desilverizing, and other operations in cases where the pots are not so placed as to allow of its being simply run out from tapping holes in the pot-bottoms. The pump consists of an iron cylinder, closed at both ends, but provided with a ball valve at the bottom, and having two pipes fixed into the top end. One pipe delivers the steam just under the cover, and the other, the delivery pipe for the lead, reaches very nearly to the bottom of the cylinder, while outside and above the cylinder it rises to a suitable height, and is curved over for the convenient flow of the lead. If a lead-pot is to be emptied, say into pig moulds, the pump is first heated to such a degree that the liquid lead will not congeal on it, and is then sunk into the metal. The steam-pipe has on it a three-way cock, which is now connected to the pipe from the boiler. The cock being first turned so that the pump cylinder communicates with the air, the lead outside raises the ball-valve and fills the cylinder. The cock is then turned so that the communication with the air is closed and steam of suitable pressure is let in. This at once closes the ball-valve, and forces the lead to rise in the delivery pipe. In this way the cylinder is emptied, and as soon as the lower end of the delivery pipe is free from lead, the steam rushes up it, thus lowering the pressure in the cylinder so far that the lead can again open the ball-valve and rise in the cylinder. The steam pressure then again rises, closes the ball-valve, and expels the lead, as before, up the delivery pipe. These alternations follow one another very rapidly, and an almost continuous stream of lead is ejected from the pump, as long as enough remains in the pot to open the valve and rise in the cylinder. German metallurgical papers speak of the pump as working very well indeed at those works which have adopted it, proper relations being maintained as to size of pipes, cylinder, steam-pressure, etc. Of course, in principle, the idea is anything but a new one. In sugar refineries, hot liquors have long been raised by exactly similar apparatus, and the "acid eggs" of sulphuric acid works are the same thing, only using compressed air in place of steam, and being made without a self-acting valve for refilling the pump, the liquor to be raised being run in from a pipe with stop-cock for each operation of lifting. The application to molten lead, however, is a new one. The *Engineering and Mining Journal* gives a description of the pump (which it appears to regard as new in principle, as it says that "it is believed that this apparatus could be used for other hot liquids and —compressed air being substituted for steam—also for cold ones"), apparently communicated direct from the adapter. From the same source it probably has received the very amusing information which it gives as to the action of the German Patent Office concerning Rosing's application for a patent for the pump. It does not appear that any objection was raised on the score of novelty, but the wiseacres at the patent office refused a patent because they discovered a reason satisfactory to their own minds why the pump would not answer. They wrote to the applicant the following piece of wisdom, which, as the *Engineering and Mining Journal* says, is "awe-inspiring:" "You have not touched the point most important to the operability of the apparatus, namely, the excessively high pressure, corresponding to the temperature of the molten lead, which the steam must acquire through contact with it, and which renders doubtful the operability and applicability of the apparatus." As our contemporary points out, the supposition that excessive pressure could be produced by superheating one end of a small steam current which is in open connection with the boiler is, of course, perfectly absurd, and astonishes us very much as coming from officials of the patent office of a country where science "lies around loose" for everybody's benefit. When this solemn suggestion was put forth, the pump was working perfectly. But the patent has never been granted, and it appears that the officials concerned are quite sure the apparatus will not work. It is some consolation, says *Engineering*, to see that thickheadedness is not a special monopoly of our own dear patent office.

COAL CUTTING MACHINERY AND THE APPLICATION OF ROPE POWER THERETO.*

By Messrs. T. and R. W. BOWER, Allerton Main Collieries.

COAL cutting machinery is a subject we have considered for the last sixteen years, but the greatest difficulty connected with this subject has been to secure a suitable motive power, inasmuch as the application of this machinery differs from all others, in this particular, viz., that the machine must be carried to the material it has to work, consequently incurring great difficulty and expense, it being impracticable to work it effectually with anything short of mechanical power, while with most of the machines they remain a fixture while the material is being brought to them. We have carefully weighed over the cost of the power which preceded our experiments, viz., compressed air, water, and steam; the former of the three named has proved most effectual, in consequence of which the two latter are rarely applied, yet there are defects connected with the application of compressed air as well as great cost of procuring it. There would be no advantage in enumerating these defects, as they are well known to all engineers.

The power we have to bring before your notice is both simple and effectual, as coal cutting machinery by this power can be applied in every mine where ropes are introduced for hauling or pumping purposes. The tail rope can be as effectually applied as the endless rope, or *vice versa*, inasmuch as you can secure the application to any number of roads branching off from a main road where the rope is used for haulage, or you can select the branch road most convenient for working the coal faces right or left of the main road. Should the coal be hauled by ponies to the ropes, it is no inconvenience whatever to the road, as the small ropes in the branch gates are neatly arranged to run on the top, supported by pulleys or rollers as the case may be; therefore, the rope is carried in the same space as ordinary bars above the ponies, so that these ropes are standing during the time of hauling coal, ready for working the coal cutting machinery at any moment when required. The ropes along the faces driven by these, as before described, are attached to a pulley at each end of the face, whatever distance it may be; these pulleys are fastened to upright posts, each about 9 in. square, and are shifted every time the face moves 7 ft. in depth, that is, 3 ft. 6 in. for each fall, and allowing the machine to bare over the face twice. Should the face be 1,000 yards in length and the coal 5 ft. 6 in. thick, the machine will produce 3,500 tons of coal without moving a post at all. In the fixing of these posts an indentation of 3 or 4 in. is required at the bottom and the same at the top; they are little stronger than the ordinary prop and bar, and are fastened by wedges in the same way. The pulleys are easily moved when the baring is completed, as their weight is only 14 lb. each. The rope thrown off, which is simply a light ½ in. rope, lies behind the plates the machine has traveled on, or can be hung up on nails driven in the props; but in our case we find it a very simple matter to lay it close to the rails on the goaf side, so that it is entirely out of the way of the coal fillers, the timber movers, or the packers—in fact, a stranger walking in the place would not know a rope was there. As to the length of the rope required for working any depth of face—say it is customary to work 100 yards between crossgate and crossgate, viz., cutting the old gate off and introducing the new one—this can be determined at the commencement, so that the full length of the rope is in use from beginning to end; all that is required is the moving of the face post in a straight line, these posts being fixed in the two outside gates, or, should it be necessary to drive from a middle gate, three posts would be required, and the work split into two sections, and by the introduction of a third pulley you can lengthen your rope every 7 ft. This is done in a very simple way, as we have introduced a clip pulley, which does not require the rope to be spliced, as the rope capled will pass over it quite as well as if it were spliced. We have a very simple method of shortening this rope; it can be done in one minute's time. We have a shackle, one side of which is tapped to receive a ½ in. rivet, which is screwed at one end, the other being made square, and the hole at the opposite end of the shackle being large enough to receive the square, so that the two shackles—one in each caple—are brought together, the screw taken out with a small key applied to the square end, put into its place again, and the rope is fit for running; we run this rope on a clip pulley of our own, so that it can be thrown on or off like an ordinary belt. No blocks are required for tightening or slackening the rope; short pieces of chain only are used for this purpose, so that the rope seldom or ever requires cutting if the proper length is got at the beginning. The clip pulley in question will run chain as well as rope without punishing either, so that we are put to no inconvenience whatever or loss of time by lengthening or shortening the rope with the above named appliances. Not more than six or seven minutes are required for putting the ropes into the pulleys connecting the machine and commencing baring operations. The rope is not to cut at all to couple up the machine, it is simply applied by a half hitch taken in any part of the rope; the machine can either be at the end or in the middle of the face, or at any other distance from the pulleys; the bight of the rope is simply taken up, put round the pulley in the form of a half hitch, and the machinery is in operation. The next question to consider is the cost. We have carefully worked out this, as it is a very important matter, and we find it a very nominal one—in fact, the ropes on the face or between the main road and the face have cost 0·032d. per ton, or say, in round figures, 30 tons coal for 1d.; in the main ropes, the cost per ton of coal produced is 0·14d., or say 7 tons for 1d.; this is worked out where the machine is worked, a mile away from the shaft, so that a mile of rope is required between the workings and the engine at the bottom. There is another advantage this appliance gives over other modes of power hitherto applied, viz., that of the power being equal to the driving of any machine hitherto constructed. It is not unusual where compressed air has been applied—unless the baring has been of a very soft nature—to find the power below the work, consequently the cost of the baring has been much increased. With our appliance we have one regular stroke, as the engines at the bottom are put on to run a certain number of strokes per minute. The ropes travel at the rate of three miles per hour, which enables the machine to run with the greatest regularity and certainty, so that any stoppage which may be caused in the process of baring is not due to any failure of the power applied. We now come to the machine, which is of the simplest construction, the framework consisting of an ordinary tram-bottom, suitable to any gauge of road, exactly like a corf, 3 ft. in length; upon this is bolted the table, or supported by four bearing screws, with a nut on the under side as well as the top, to enable the machine to be set to the angle of the coal. The table has three straight sides, the fourth side being in the form of a quadrant, with an opening of the same form, 1 in. from the outside, and about 1 in. wide. In the middle there is a circular recess about 2 in. deep, 14 in. in diameter, in which is placed a circular bearing made to fit and revolve, carrying a cross shaft in horizontal form, upon which is keyed a beveled pinion wheel 8 in. in diameter, 15 teeth; at the other end is a hole slotted for cottering on the cutter-bar, the shaft altogether being about 2 ft. 4 in. in length. From this circular bearing is a bracket projecting about 5 in., into which is inserted a screw, by which the bearing pinion wheel is traveled to suit any angle the cutter is required to travel for doing its work. By this means you can apply the machine to any part of a face, and set the cutter-bar to right angles of the same, putting it in to the depth you require to cut, as the bearing travels with it (the cutter-bar) when it is thus cottered on to the shaft. Near to the cotter hole in the cutter-bar is another small bearing about 2 in. through, which travels in the recess formed in the quadrant, so that the object of the quadrant with this bearing is to support the cutter-bar, holding it stiff and steady, so that the hole cut by the bar in the coal is straight and uniform through the whole length of the baring, the size of the opening being determined by the diameter of the cutter. In our working a 5 ft. 6 in. seam of coal, we have found it necessary to have the diameter of the cutter from 4½ in. to 5 in., so as to avoid wedging or any other appliance for getting the coal over, ready for filling after the holing is completed. This horizontal shaft is driven by another bevel wheel, keyed on to a vertical shaft, which is about 14 in. in length, this shaft being supported from the table in question by two center pillars and a cross-bar, the whole being cast with the table, a recess being left in the center of the cross-bar for a pedestal, in which is fitted a brass bush which forms the bearing; this can either be turned to fit in circular form, or put on in two halves with a cap and bolts, the latter being preferable, so that it can be reduced when required from wear and tear, the bevel wheel being about 16 in. in diameter. At the top of the vertical shaft is keyed on an ordinary pulley 2 ft. in diameter, with a tread of 3½ in. broad, plain, no groove. Around this travels the rope which drives the machine, with the half-hitch, as previously

* A paper read at a meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers, on December 7, 1885.—*Colliery Guardian.*

described, and assists very much in propelling the machine forward as it finishes its work. When the ropes are standing, if necessary, without being thrown off the pulley, you can travel the machine by hand to any part of the face you wish. Any other power required to assist in propelling the machine when in operation is done by the ordinary catch gear, which gives the motion to the catch from a worm keyed on to the vertical shaft at the under side of the pulley named. Next we come to the cutter-bar, which represents a hexagon with six equal sides, this being necessary to hold the washers, keeping them stiff and firm to their work. At one end of the bar is welded on a socket, with a cotter hole corresponding with that in the horizontal shaft, so that when the machine has done its work the cotter is knocked out and the bar brought to the surface, if necessary, with the cutters. The machine can either be left on the face or moved (as easily as moving a corf) to any pass-by or recess near at hand, to suit the convenience of the men working, as a couple of men have no difficulty in putting the machine away to suit their convenience; all there is left of it remains in the space about 3 ft. in length and 2 ft. in width. Our men find no inconvenience from the machine when the cutter-bar is disconnected, and seldom remove it from the face, as it is easy to put it out of their way when filling the coal out. The washers, which are made to fit the bar, are 1¼ in. broad and about ¼ in. thick. These washers are drilled and tapped on every flat, so that there are six cutters in each washer, the cutters being made of steel about ⅝ in. diameter, screwed at one end, which is reduced to ½ in., the end of the cutter being dimond-shaped. Thirty washers are required for baring 3 ft. 6 in. under, so that there are 180 cutters at work at one time. These cutters, you will perceive, are easily put on and taken off with the washers, as they are all filed off inside the washers, the washer being the only means by which they are fastened. At the other end of the cutter-bar is a thread 1 in. in diameter, and a nut screwed on, so that the cutters cannot work off the bar; the nut is also tapped on each square, and cutters fixed in the same form as the washers; therefore when the machine is working, the whole thing is secured by the nut. When the cutters require sharpening, the bar and all come to the top, being put on a loaded corf in the same way as the miner sends out his picks. The nut is taken off at the end, and all the cutters slip off the bar with the washers; it is not necessary to put them into the fire to sharpen, as they rarely lose their temper; they are applied to a grindstone, and, being diamond-shaped, are very easily sharpened; the stone is driven by steam, and a man will sharpen the whole of the cutters in an hour. A set of cutters newly sharpened will bare in ordinary baring from five to six hundred tons of coal in a seam 5 ft. 6 in.; if it be very drossy or full of hard matter, they will require sharpening a little oftener. The cutter-bar travels at the rate of 500 revolutions per minute, and will bare, on an average, in any reasonable baring from 16 to 18 yards per hour. In our case we find great advantages both in the sample of coal, also a great reduction in the amount of small; further, the cost per ton is very much reduced.

HANDLING A LOCOMOTIVE.

AT the Union Pacific round house a reporter of the Denver *Tribune-Republican* recently picked up several bits of information relative to handling an engine, which may be of more than passing interest to the general reader. In the first place, there is this curious paradox to be intellectually assimilated: Take twin engines, two engines made from the same plans, the same templates, and these two engines will act totally different. One will be a better steamer than the other, and will work easier, or will burn less coal, or pick up a train and run off with it more quickly than its sister engine. Engineers will tell you this the world over.

As the late Dundreary was wont to observe, "It's one of those things no feller can find out;" the only philosophical explanation being that, according to natural laws, there is no such thing as mathematically exact reproduction of like conditions. Any scientist will say that. Another nut for the mental tooth to crack is the fact that no two engineers are alike in the handling of their machines, and because an old, tried, and trusted runner of twenty years' service prefers one way of treatment, either in running or in repairing breaks, it does not follow that every other way is necessarily wrong. But at the same time, on general principles, the man who is longest in service, has met with the fewest mishaps, and whose engine makes the greatest mileage between trips into the shops, is the man whose methods of using an engine are the most likely to be correct. Machinist runners would be considered naturally the most competent and trustworthy men above all others, yet suggest that to an old engineer and you will see the corners of his mouth turn up in a pitying smile at your verdancy. It is good to have a machinist runner around in case of accident, but the writer has been told by men of experience on Eastern roads that, taking all in all, the thoroughly apprenticed fireman, with just enough shop experience to teach him the use of tools, makes the most reliable man. An Old Colony railroad engineer, of five years' experience on the left side of the cab, told the writer that the great trouble with machinist runners was their poor knowledge of firing, which kept them in hot water with their firemen, and the lack of judgment where mental alertness was demanded.

"Where would you advise a fireman to begin?" asked the reporter to a runner of experience.

"On a construction train, or a freight," was the prompt reply; "and for this reason, that comparatively little care is taken of that class of engines. I know of a night freight locomotive on the Boston and Albany road that was run for a month without even wiping her, just to see how long an engine could go without care; but she got into such a mess that the master mechanic was glad to run her over the pit and put her in shape again. Consequently, something is all the while breaking or giving out, and has to be mended or patched up, which is mighty good practice for the fireman. On a passenger engine everything is kept in tip-top shape, so that the fireman has no such opportunity for acquiring practical knowledge. How long must a man fire? Well, no two men are alike. I know of one man who only fired one month before he had an engine, but I guess he had been a student in some institute of technology, and was fitting himself either for a master mechanicship or to be a civil engineer. I know some runners who fired five years before shifting to the other side of the cab; but a smart young fellow who can show his boss that he is quick and capable, and make some attempt at mastering the scientific points of locomotive management, ought to have an engine in a year. In that time he will have so mastered the problem of distance, signals, time tables, and land marks that every switch, curve, etc., will have become indelibly impressed on his mind, and he will be prepared to act quickly without stopping to study what to do."

The reporter's informant was called away here, so another engineer, a careful-looking man who was examining his eccentric, was interrogated.

"Your looking under your engine makes me think of inside connections, but I haven't seen any in this section."

"Neither have I," was the quick reply. "They had one on the Chicago, Burlington, and Quincy, but I guess she's gone to the scrap heap. The New London Northern, the Boston and Providence, and the Providence and Worcester roads have them yet, though they are being gradually superseded. They are fearfully mean things to get at even in oiling, and if anything breaks it's the old boy's job itself to make repairs. You see the forward driver axle is bent in two places as cranks, like as you see on a steamer's crank-shaft, and the connecting rods make direct connection with these cranks as on outside connecting engines they do with the crank pins on the drivers. So all the running gear, eccentrics, and all are in there in a heap, and that, with the difficulty in making good turnings for the cranks, has driven the style out of use. But there are some mighty good points about inside connections, with all the faults. The cylinders are practically in the smoke arch, which keeps them hot in the coldest day—a big factor in saving steam. Then, the movement being on the central line of the engine, the motion is easier on the machine as well as on the occupants of the cab. The advantage of having the cylinders protected thus is found to be so great that there is talk of readopting inside connections on some of the Eastern roads, but I hardly believe it will be done."

As the engineer turned to look over his links, or eccentric hooks as they are sometimes called, his questioner asked for points in hooking or linking up an engine while on the road.

"This linking up business, you want to understand," answered the runner, "is the same as the variable 'cut-off' on a stationary engine. You set your 'cut-off' for the amount of steam to be given the direct action on the piston, say four or six inches, that is, the valve does not uncover the full width of the inductive parts, but just enough to give the desired amount of live steam, which acts for the rest of the piston travel on its naturally expansive properties. Of course, the least amount of steam you can do the required work with is the most economical way, and this varies. In climbing a hill a man runs slowly and very likely uses live steam the full length of the cylinder, but were he to do this while running fast the engine would be racked all to pieces in short order, and the coal thrown out of the stack faster than the fireman could shovel it in. I take care to link up my engine just as far as I can, that is, to pull up the reverse lever till within two notches of the dead center on the quadrant, giving me four inches of steam and running the rest on expansion. This of course is not on mountain grades, where harder work is called for. It is easy on the engine, it is easy on the fireman, and saves fuel to run with the reverse lever set up as high as possible. I've seen runners use eight inches on a level grade, but their firemen feel like hanging their shirts on the furnace door to dry at the end of the run."

"If a link-hanger breaks, as they sometimes do, how would you mend it?"

"Fit a piece of wood in the link above the link-block so as to support the link in position to work nearly full stroke, that is, with the reverse lever half way or more down the quadrant, drop the other link to the same position, and, by being careful, a runner can manage to pull his train. But, remember this one thing, don't attempt to reverse the locomotive until it comes to a dead stop; then, if it is necessary to back up, fit a longer piece of wood in the link, so as to support the link in position to back up. If either or both of the tumbling-shaft arms should break, apply the same doctrine to both links, and make the block the same length. They should be securely tied in position with bell cord. Run carefully to the nearest station where another engine can be had, and change.

"Here is something I want you to look at," continued the engineer, turning to the cylinders of his engine. "See those pet cocks in under the saddle? They connect directly with the steam pipes at the entrance to each of the steam chests. They open from the cab with the regular pet cocks under the cylinders, and when open they let all the condensed water out of the steam pipes, so there is so much less to run into the cylinder and cause trouble. With such an arrangement you will never see dirty water shooting from the stack on suddenly opening the throttle, and beslobbering the engine all over with smut. How do cylinder heads blow out? Well, one cause, though a rare one, is a follower-head bolt working loose. Of course, falling between the piston and cylinder head will break the latter in two. Sometimes an engineer is careless about letting the water out of his cylinders, or the cylinder cocks get stopped up, and the first thing he knows there is a 'water hammer' formed that lifts the cylinder head in short order. Then if anything about the cross-head breaks so that connection is severed with the driving wheel, why all restraint on the piston is lost, and with 125 pounds of steam behind it the piston knocks the opposing head out of time in an instant. If a back gives out, cross-head, guides, and yoke are twisted up like snarled cotton waste. Cylinders crack once in a while, particularly after having been bored out two or three times. They get thin then, and have lessened power of resistance to pressure. A man ought to take his front cylinder heads off every once in a while to see if the follower bolts are snug, and that the piston is not worn so that steam will blow through, though as for this last an experienced ear will detect the trouble before waiting for periodical examination. Is spring packing in use? No, sir. That went out of style long ago. The springs were forever getting out of kilter; steam packing is the thing now. Here is a good feature—this air valve on top of the steam chest. While running, the valve is closed by steam pressure; when steam is shut off, the valve opens and air rushes in, cooling off the valve and its seat, and also the piston. I open the cylinder cocks at the time, which establishes a good circulation."

"What's your valve travel?"

"On most of our engines it is 5 inches, but, of course, you know, or should know, that when steam is shut off, the reverse lever is set at its furthest notch, which gives the valve full travel. If this were not done, the valve would wear the face of its seat uneven in a short time. And, no doubt, you have noticed how an engine eases up in labor, as it were, when, after shutting off, the valve is given full play. It would be like trotting a horse continually on a dead tight rein when there was no occasion for it. And speaking of valve seats reminds me. The Pennsylvania runners were complaining a few years ago of the inexplicable excoriation of their valve seats. Engine after engine came into Altoona for a new valve seat, till the general superintendent set the company's chemists to solving the mystery. Well, these scientific fellows found that the road had been receiving lubricating oil that was full of free stearic acid, and that when subjected to heavy steam pressure acted precisely as when in the steam chest. You bet there was no more such oil sent to the Pennsylvania."

"Did you ever break a driver?" asked the listener, as he saw his instructor in locomotive running examining his brasses.

"Yes, sir. I've had a forward driver break smack off the axle, and yet I got into the division station all right. It was ten years ago. I was running between Chicago and Galesburg, on the Chicago, Burlington, and Quincy, at thirty-five miles an hour, when crack, and a snapping sort of a crash, and off came my wheel, stripping the entire side. I stopped quickly, took down what of the rods the accident had left, jacked up the axle till in the regular position, when I removed the 'cellar' from the driving-wheel jaw and inserted a square block of wood with a wedge-shaped piece cut out of the top surface, in which the axle rests. Then throwing the valve on that side on the center, I pinched the valve stem gland by screwing one side up tight, and blocked up the crosshead by inserting a piece of joist between that and the back head of the cylinder; and after removing the side bar on the other side, I ran the train all straight into Galesburg, slowly but surely, with the good side.

SHAFT SINKING THROUGH QUICKSAND.

THE *Evansville* (Ind.) *Journal* contains the following very interesting account of the sinking of a shaft in that vicinity:

The report was current a few weeks ago that rock had been struck at the Acme shaft of the Belt Road Coal Company, and that they were trying to cut off the lower water, and prevent it from forcing the sand under the curb, and between it and the rock, and that it was known to be a very difficult undertaking. The reporter hearing that this had been accomplished, visited the mines to learn the facts, and on arriving found the parties having a jolly time and in good spirits. On making inquiry, it was learned that they had fired two large blasts of dynamite on the rock to shake and settle the timbers firmly down on the rock, and prevent any sand or water from rushing in on them after they had commenced to sink into the rock.

On descending after the first charge of dynamite had been fired, the men were agreeably surprised to find that the sand and water were quiet, and did not indicate any disturbance, and after the second charge was fired they found the sand entirely cut off, and only making a small quantity of water. This shaft was commenced last spring by Mr. Jabez Woolley, Sr., and his associates. The ground passed through is as follows.

One and one-half feet of surface soil.
Twelve feet of clay.
Five and one-half feet of sand and loam.
Four feet of sand not very quick.
Forty-five feet of quicksand.
Three feet of blue clay.
Six feet of quicksand and gravel.

From the foregoing it will be seen that there is nearly sixty feet of loose or wet sand; forty-five feet of this made water at the rate of 50,000 gallons per hour. Mr. Woolley found that to handle this large volume of water, pumps and machinery would have to be purchased, which would require more capital than he had at his immediate command, so he concluded to sink the shell of an old boiler inside the timbers. This he did, and succeeded in sinking it ahead of the shaft timbers, and with the aid of two siphon pumps, furnished by the Mechanics' Foundry, pumped enough sand and water out of the boiler shell to sink both shell and timbers to the blue clay. When the timber, or curb, reached the blue clay, it cut off the water to so great an extent as to deprive them of a sufficient supply for steam purposes, as they were depending entirely upon the water made by the shaft. But the worst was yet to come, for underlying the blue clay were six feet of sand and gravel, with nearly twice as much water as before, and with an immense pressure. To have pumped the shaft dry would require more pumps than the shaft would hold. The next question was, how to sink the timbers without handling this large volume of water. Test pipes were driven down, and the force of the water would throw sand and gravel through the pipe with great velocity. A novel plan was adopted. By placing a steam valve on the test pipe, the water was used to force the sand and gravel up the pipes, and in this way the sand and gravel were undermined and the timbers gradually sunk until rock was reached.

The most remarkable thing about this is that the shaft is perfectly straight and the timbers are as solid as when put in place. It must be understood that all the timbers were put on at the surface and sunk down the shaft.

The shaft is eight feet by sixteen feet in the clear, with one six inch and one eight inch solid partition, the sides and ends being 3x12 timbers laid flat, and each layer or set is tarred and spiked. They are perfectly water-tight. The whole shaft is loaded with sand, except a small space in the center for a couple of men to work in and for hoisting purposes.

The plan or process of sinking through quicksand is very cheap, and has not cost as much as to go through the same distance in hard rock. It has cost in many instances from $50,000 to $75,000 to sink through less than

one-half the distance of sand and water that has been encountered at the Acme.

Good practical miners and mining experts have pronounced this as one of the cheapest and most skillful efforts at shaft sinking through quicksand on record.

Great credit is due Mr. Woolley and his men for skill, patience, and perseverance. They have had to combat many obstacles and unfavorable comments from time to time. It has been repeatedly predicted that this shaft would never be sunk through twenty feet of sand with the quantity of water which the sand contained, but the Acme people keep steadily ahead, never losing their equanimity, and retaining absolute confidence in the success of their efforts eventually, and as a result there is no stock on the market for sale.

INDICATING FIRE DAMP IN COAL MINES.

THE apparatus invented by Henry Guy Carleton, of New York, for indicating fire damp, is herewith shown. It consists, essentially, of one or more indicating balances to be permanently placed in a goaf or drift of the mine, as shown, and a registering balance to be used by the observer in the testing room, connected by well-insulated wires as shown. Each balance holds in equilibrium a thin glass bulb of about 300 cubic inches capacity, hermetically sealed. They are counterbalanced at the same moment by the weights, W and W', respectively, and hence will be equally affected by future variations in the atmospheric pressure. Attached to the vertical arm or pointer, H, of each balance is a soft iron needle, *d*, gilded to prevent rusting. Its ends plunge freely into helices of insulated wire, *a* and *b*.

The helices on both instruments are exactly of the same size and electrical resistance, and of sufficient internal diameter to exert but feeble influence on the needles with an ordinary current. The right-hand helix of balance No. 1 is connected with the right-hand helix of balance No. 2, and is supplied at will from battery II. with a current whose strength can be lessened gradually and delicately by resistances thrown into the circuit by the rheostat, as shown, enabling the magnetic force of the helices to be regulated to a nicety. The left-hand helices are similarly connected, through battery I. and rheostat (Diagram, opposite).

The vertical arm, H, of balance No. 2 has a platinum tip capable of electrical contact with insulated screw, *c*. Connection from binding post 4 to the vertical arm is made by means of the mercury cup, *m* (see engraving), into which a wire from the beam is dipped. By contact between H and *c*, the relay in the observing room is kept closed. Breaking contact opens the relay, whose back stroke shunts the local circuit on the bell, ringing it continuously. The resistance coil, *g*, connected to binding posts 3 and 4, prevents a spark passing when H and *c* break. The case surrounding balance No. 2 is of marble or unglazed tiling excluding air currents and dust, yet admitting gases by diffusion. Chloride of calcium, in the holder, D', keeps the interior free from moisture. The whole is protected from injury by a perforated iron case, as shown. Once placed in its position in the mine, its temperature will be constant.

Balance No. 1, in the observing room, is provided with two riders, moved along the graduated beam as shown. If more delicate readings are desired, additional riders of less weight may be also employed, a separate way being provided on the beam. Balance No. 1 is incased, dried by chloride of calcium, and placed in a room artificially maintained at constant temperature by means well known.

By this arrangement it will be seen :

1st. That as the two bulbs, S and S', are equal in bulk, and balanced at the same moment, they will be affected equally in weight by an increase or decrease in atmospheric pressure.

2d. That the right-hand helix of each instrument will exert the same amount of force on its responsive needle, both being supplied with current from the same battery, and that the same rule will apply to the left-hand helices.

3d. That as each instrument is kept in an atmosphere of constant temperature and equal hygrometric condition, it will only be sensitive to a change in the pressure of said atmosphere or a change in its atomic weight.

GRADUATION AND ADJUSTMENT.

Both instruments are balanced at the same moment by their weights, W and W', respectively. The case of balance No. 2 is then filled with pure fire damp at normal pressure, obtained from a "blower" in the mine. (This will obviate the necessity of correcting for that percentage of carbonic acid always associated with marsh gas in fire damp, as would be necessary if pure marsh gas were used).

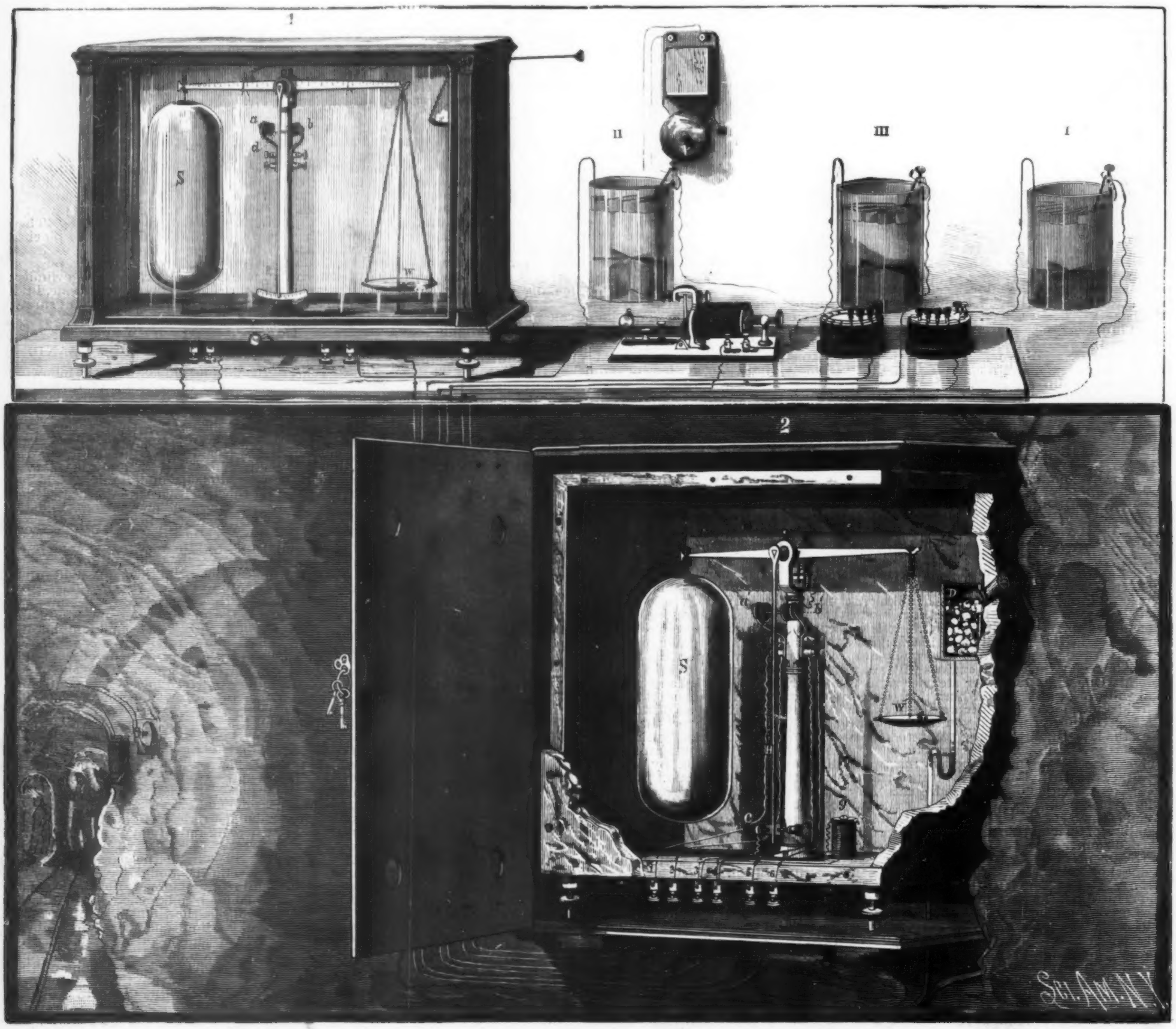
Care, of course, is taken to keep a stream of the gas flowing in, to counteract the diffusion of air through the case. Bulb, S', will now sink, its increase in weight being about 39 grains, H will break contact with *c*, and the bell rings. The observer now switches on battery I., which applies a force of say 45 grains through helix, *a'*, to the needle attached to the vertical arm of balance No. 2. This more than compensates for the increase in weight, H is brought back to *c*, and the bell ceases to ring. The observer now throws in small resistances until H breaks again, and thus finally satisfies himself that the amount of force applied through helix, *a'*, of the distant instrument is just enough to balance it and no more. Now, as this amount of force is also exerted by helix, *a*, upon the needle of balance No. 1, its equilibrium is disturbed. Rider, *r*, is therefore shifted until equilibrium is restored. The position of this rider equals the force applied through helix, *a* ; equals the force applied through the helix of the distant instrument, No. 2 ; and necessarily equals the increased weight of the bulb, S', in pure fire damp. From this point, therefore, to zero, the observer graduates his beam into hundredths and minor subdivisions. The graduation is then made in similar manner for carbonic acid, employing rider, *r'*, and battery II. In practice, these graduations would be made before the instruments were placed in position, allowances being made for the depth and increased temperature to which each balance is to go.

Thus adjusted, the instrument will act under the conditions named as follows :

1. *Rising Barometer and no "Fire Damp."*—The pointer of the observer's instrument will be deflected to the left. On applying battery II., both balances will come to equilibrium with the same amount of electrical force, the distant instrument indicating by the bell, as described.

2. *Falling Barometer and no "Fire Damp."*—The bulbs in both instruments will sink when the atmospheric pressure is below the point at which they were adjusted. Equilibrium will be restored to both by force applied from battery I., as described.

3. *Rising Barometer and "Fire Damp."*—The observer will find, on applying current from battery II., that the distant instrument comes to equilibrium with a weaker current than his own. Keeping that in equilibrium by the current, he moves the rider, *r*, until his own balance is in poise. The position of this rider necessarily gives him the percentage of fire damp in the case of the distant instrument.



HENRY GUY CARLETON'S INSTRUMENT FOR INDICATING FIRE DAMP IN MINES.

4. *Falling Barometer and "Fire Damp."*—Both balances are disturbed, but balance No. 1 is only affected by the change in barometric pressure, while balance No. 2 is affected both by that and by the fire damp. Hence, the power now applied by battery I., sufficient to balance the distant instrument, will overweight the observer's. The amount of this overweight is determined, as before, by rider, *r*, and the percentage of fire damp is given.

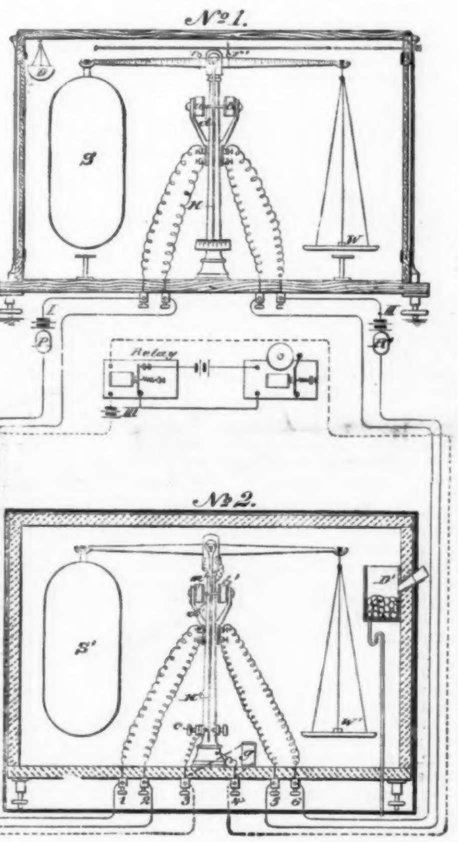
The tests for carbonic acid are similar, rider, *r'*, being found necessary to restore equilibrium to the observer's instrument.

GENERAL SYSTEM.

Applied to a general system, a number of balances like No. 2 would be placed in various portions of the mine, the left-hand helices all being on one circuit, and the right-hand helices on another, connected with the one balance to be used in the observing room. Separate wires would be run for the bells serving to indicate the movements of each instrument. The tests would then be simultaneous, full battery power being thrown on, and then gradually weakened by the rheostat; measurements being taken on the observer's balance as each bell gave warning that one or more of the distant balances were in equilibrium. These tests could be frequently made, and notification promptly signaled to the miners in any drift in which a dangerous percentage was observed, or to the fire boss and his assistants.

NOTES.

1. The percentage of carbonic acid exhaled from coal usually runs from 0·30 to 2·1 per cent. in fire damp, varying in different mines, but practically constant in any one. There may be a sudden increase by an explosion, but ventilation would soon restore the normal condition. The quantity produced by the lamps and men is insignificant, since the ventilation necessary to keep the mine free from fire damp sweeps away the carbonic acid from this source as fast as formed.



INSTRUMENT FOR INDICATING FIRE DAMP IN MINES

2. Should it be desirable to test for marsh gas only, balance 2 may be surrounded by an air tight case, provided with a tube opened or shut at will by a mercury valve operated by an electro magnet controlled from the observing station. This tube would be opened for, say, five minutes. During that time the external gases would diffuse perfectly through the tube into the case, but both moisture and carbonic acid would be immediately absorbed by caustic potassa placed in D'. The tube would then be closed, and measurements taken, pure marsh gas being the standard. These tests would be made as often as desired, the observer having full control of the valves on all the instruments and operating all on one circuit.

3. While a separate circuit is shown for the right-hand or left-hand helices, it is practicable, by a simple device arranged by the inventor, to operate either helix at will from the observing station, and yet use but a single circuit.

4. With bulbs of 300 cubic inches capacity, a balance weighing to one-tenth of a grain will give the percentage of marsh gas to one-third of one per cent. The bulbs weigh 6 ounces. This weight may be lessened 86 grains by filling them with pure hydrogen. A reading to one-third of one per cent. is close enough in practice.

5. The instrument is especially designed for use in goaves, where large accumulations of the gas are more liable to form. A decrease in atmospheric pressure forces it out in the workings, where it may be fired by a shot, a defective lamp, or other causes. It having been settled that the explosions supposed to be wholly due to coal dust depend on marsh gas in conjunction with the dust, the necessity for close watch upon even small percentages is obvious.

6. As marsh gas spreads with tolerable rapidity, one instrument will guard a considerable area, especially in a goaf where ventilation is neglected.

AX MAKING.

AXES are made from iron with a steel bit, or from iron with a steel bit and head, or from steel alone. In the latter case two kinds of steel are used, the better quality, which is rich in carbon, being used for the bit or cutting edge. The various stages required to produce the ax made from iron with a steel bit are here given. The all-steel ax is made in a similar manner.

The iron bars, about 3×⅝ inches and 12 to 16 feet in length, having been selected with care as to uniform quality, freedom from impurities, and good welding properties, they are first cut into blanks from 7 to 13 inches in length, the length varying according as the ax is to be light or heavy. The blank goes to the forge, where it is heated, great care being taken that the degree of heat is never so great as to burn the iron. It is proper to remark here that the employment of careful, experienced, and conscientious workmen is very important, as careless employes would be almost sure to produce faulty work, no matter how high the grade of iron or steel furnished them might be. After being heated, the blank goes to a roller, where it is drawn to the required shape, then to the "eye" former, where a single blow brings the ends together (Fig. 1), thus forming the head and the two sides of the eye where the helve is to be inserted. The lips remain slightly separated for the insertion of the piece of steel which is to form the bit. After this operation, the blank is again heated, this time in another forge; and the steel to form the bit, having been brought to the proper heat, is inserted and welded under a nicely adjusted yet powerful trip-hammer. Another heat is taken, and then another and lighter trip-hammer brings the tool to a higher degree of perfection, when the ax is ready for the grinding-room. In a large factory there are many forges, which enable the firm to turn out hundreds of completed tools daily. The trade demands two styles of this ax, one of which is called the "inlaid," described above. In the other, called the "overlaid" (Fig. 2), the edge of the steel bit is split to receive the iron below the "eye" before being welded under the trip-hammer, as above described. While one style is perhaps as good as the other, each has its advocates and friends, and the Pyramids could be as easily removed as to change the mind of a woodchopper who had become wedded to the idea that an "overlaid" ax was really the only one made upon truly scientific principles.

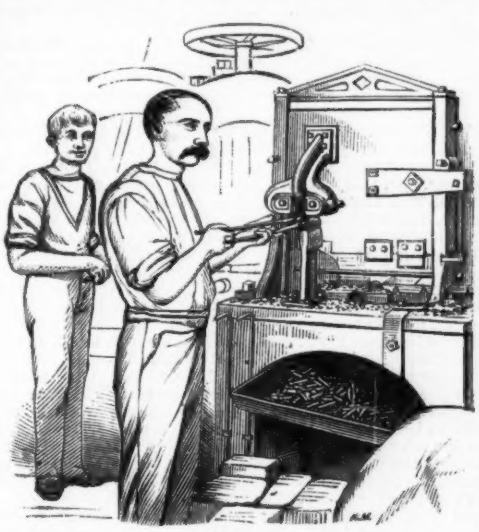


FIG. 1.

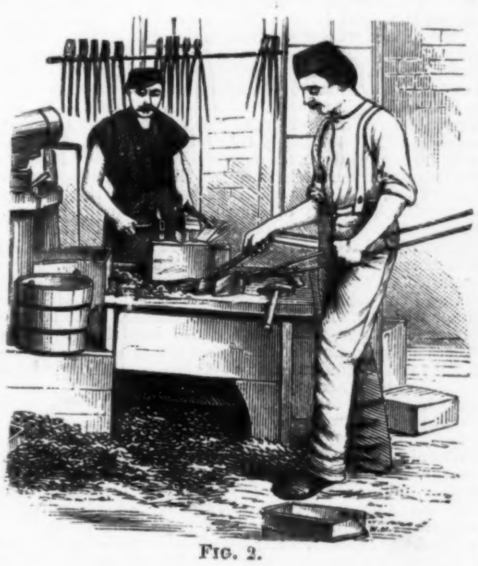


FIG. 2.

The grinding into shape is done on large grindstones which are run wet. The dust from these stones is nearly impalpable, and is very injurious to the operatives, it having been estimated that their average service in this particular employment could not be more than about five years. Some wear a wet sponge over the mouth and nose while at work, to prevent the dust from entering the air passages of the head, throat, and lungs. From the accompanying engraving (Fig. 3), the position of the grinder will be seen. The pressure of the ax against the stone is regulated by the weight of the operator on the seat rest. During this stage of manufacture the "bevel bit" or other shape is given the blade, as desired. After being finished in the grinding-room, the ax is covered with a preparation to prevent rusting, as the blade must be bright when taken to the tempering department. The most important process through which the ax passes is that of tempering. Our engraving shows the chief of this department at work (Fig. 4). The gentleman will no doubt be recognized by some of our readers, as he is widely known for his experience and skill in this branch of the business. The tempering, as we have said, is most important. The ax is placed in a furnace or forge and allowed to remain until heated to a cherry red, when it is withdrawn, and, when somewhat changed in color, is plunged into a vat of salt water for a few seconds. The color of the steel forming the bit is carefully watched, as it is the only guide the chief has to determine when the proper temperature has been reached, and consequently when the right temper has been given the tool.

FIG. 3.

The next step is to the polishing-room, where emery wheels and buffers bring out the surface as bright, almost, as a mirror. The now nearly finished tool is taken to the packing-room, where every ax is weighed, inspected for possible flaws or imperfections, stamped with brand and weight, wrapped in paper, and put up in boxes containing one dozen each. These boxes are carefully marked with stencil plates, after which they are ready for shipment to home or foreign markets.

Leading manufacturers, says *The Stove and Hardware Reporter*, have reached such a degree of perfection that most of them guarantee the quality of their goods, and will replace any found to be too hard or otherwise imperfect if the broken or damaged ax is returned by the dealer through whom it was purchased. Some axes are sold ready "hung" or fitted with the helve, though most buyers prefer to choose a helve of a certain length and shape and have the ax filled to suit. More light or medium weight axes are now sold than formerly, as it has been demonstrated that more work can be done with a light ax, with the same muscular exertion, than with a heavy one. In selecting an implement of this kind to sell or use, care should be taken to purchase of a reputable dealer or manufacturer, such as may be found represented in these columns from time to time. See that the finish is good, that the shape is symmetrical, or "well balanced," that the bit is neither too thick nor too thin; and if the material used in the construction of the ax has been well chosen and properly worked, you can go your way with a feeling of perfect satisfaction.

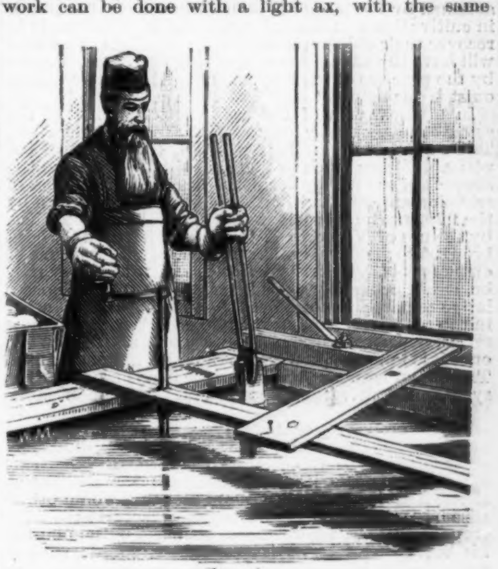


FIG. 4.

The engravings are from photos by the Francis Ax Co., of Buffalo, N. Y.

THE drinking of a large glass of water off rusty nails removes the taste of cod-liver oil. The rank taste of the oil is changed to that of fresh oysters, and the unpleasant regurgitations disappear.

SUGAR.

By G. BUCHANAN.

THE sugar-cane had, and not so very long ago, the monopoly of sugar production. The enjoyment of a monopoly is seen, only too often, to be inconsistent with progress; and the sugar-cane industry continued to be carried on in the old-fashioned way, with unconcern and disregard for the development of a rival product. The magnitude to which the latter has attained so recently and suddenly seems almost abnormal. If it be as permanent as great, the planter, it is pretty plain, will have to take special care, or leave his place to ruin. Coffee and cotton have ceased in our West Indian colonies. Are we to acquiesce quietly in the increased loss of the sugar also? The cane is not beaten on its merits. No agricultural product, it used to be said, gives a return equal to that from a good sugar estate. And when we see how much has been accomplished by its favored rival the beet, it would be unreasonable to doubt the capability of the cane, with like invention in machinery, selection of seed, and technical skill in workmen, to fulfill a similar success. All classes would benefit by an increased supply of cane-sugar, and energetic workers ought not to let the country be dependent for price on the adventitious supply of beet. The overproduction of beet-sugar in Germany, which ensued from the opportunity of making large profits under the system of sugar duties and drawbacks, will, by the attending abasement of the price, and from which it is probable there never will be a complete recovery, reduce the area sown for the coming and succeeding crops, and the sowings are likely to be diminished in another way. The German Government, it is understood, are not satisfied with the share of the profits of the beet-sugar manufacture that accrues to the State, and have in contemplation the raising of the duty from 80 pfs. to 93 pfs. per centner, or hundredweight, of roots. The drawback upon export of the sugar to be kept as it was, on the basis of an assessment of 10 marks per centner of sugar made. This indicates that 10¾ cwt. of roots will then be taken officially, instead of 12½ cwt. as formerly, to make 1 cwt. of sugar. And the proposed increase of tax, if sanctioned by the Reichstag, would thus, in years of ordinary fertility, greatly lessen, if not do away with, the bounty on export, which has been so long and loudly complained of in this country as a grievance. Though bounty, it was not in the meaning of a premium from the State to encourage sugar-making, but simply a benefit to the producers from their own skill and ingenuity, obtained by turning to profit the chance they had of getting more sugar from the roots than the excise assessment; a thing that has happened before now nearer home, when the march of improvement has outstripped legislation in such matters. The advantage taken of the Netherlands' system of duty by classification of color, to bring beet-sugar from Germany, artificially colored in the lowest class, and ship it for drawback, has now been put a stop to. And the bounty obtained in the United States from the drawback, being unchanged when the duties were altered, cannot continue long after public attention is directed to it. But there is not the objection there is with beet to receive pure granulated cane-sugar from our friends there, if they please to supply us at a cheaper rate than they pay themselves. However, the returns of the last two seasons show that the beet yields a larger percentage of sugar than is represented by the figure 10¾; for the last two years were good and plenteous years, and if the years to follow should happen to be characterized by the same exuberant richness and weight of roots, our cane-sugar growers and refiners will find things more comfortable than before. The enterprise of the beet cultivators and fabricants, and the better modes of procedure followed in their work, have given them a perfection of process against which the cane-sugar producers will find it hard to contend. But the excellence attained by the former is perhaps now at its best, both in cultivation and manufacture, and in the struggle to recover their old supremacy in the markets the latter will have the advantage of knowing the lessons taught by the practice of their opponents. Here "our antagonist is our helper."

In any near view of the case, the enrichment of the sugar-cane naturally comes first for consideration. There are more than half a hundred varieties of the plant, differing much in the quantity of fiber and the amount of sugar they furnish. And the advantages of selection and good cultivation of the fittest is shown by the immense improvement made in the beet, which has, by the use of Vilmorin seed and high farming, been brought to yield, it is said, one cwt. of sugar from 8·34 cwt. of roots. This was in Germany, where they may be, it will be readily owned, great in theory and speculative research, but are held to be somewhat wanting in the practical acumen we note complacently in ourselves, which enables us to carry out a thing, when once it is taken up, and leave foreign nations behind. The object is sugar, and experience says much for the system of cultivation upon which the German fabricants lay stress. It requires the farmer to content himself with growing a comparatively small crop of roots per acre, and to develop the sacchariferous quality of what he grows to the utmost by "forcing." The care for quality rather than quantity in the cultivation effects a saving in the labor and fuel that would otherwise have to be expended in manufacturing a large crop of watery, unsweetened roots. To the planter, his big crop of canes is likewise, as regards time or money, a heavy charge and great inconvenience. To speed the work and labor of crushing, the three-roller steam mill was designed, and it made quicker work with the canes, but not better work than the two-roller cattle mill, which has been known to squeeze out sixty per cent. of juice. To get better results it was screwed up, and strengthened, and enlarged, and more rollers added. Yet the outcome of all the improvements is a roller mill, and nothing more. It is still an unsettled question how far pressure may be exerted commensurable with profitable effect. And invention has not sought out a more perfect instrument. To make a reduction in the number of canes and no diminution in the weight of sugar per acre would answer well for the planter. And of his wishes there can be no doubt, could these be realized. Nor is the thought Utopian, for it appears that in Louisiana, two or three years ago, an overflow, and consequent loss of growing cane, left the planters with little hope of regaining expenses, but the canes, though short and slim, were found to contain an unexpected quantity of saccharine matter, and the result was an agreeable surprise. The sugar in the cane, it seems to be agreed, is not drawn from the earth, but is elaborated from the carbonic acid in the air by the direct influence of the sun on the green leaves. Thus nature herself points out to us the need of room and space for the growth of the cane in all its fullness, and that too close planting, by keeping out sunshine, prevents a healthy vegetation. Without a free access of air and sunlight, the power of the plant to produce sugar is weakened. And since there is no exhaustion of the soil by the formation of sugar, and plants take up only the nourishment they actually want, no more manuring is demanded than will restore the wastage of the other matters taken up from the soil by the crops of cane raised from it. If canes are ill-fed, a low vitality might not be able to withstand disease. And this is not a groundless apprehension, for in Java it has lately been discovered that the growing canes were affected by a disease, the precise nature of which is as yet not known.

Single crushing is inadequate to express the full amount of juice from the cane, and it was supplemented by double crushing. But neither did double crushing suffice, and then the megass was drenched with water and steamed preparatory to the second pressure. But even so, imbibition did not effect a saving of all the remaining sugar; there is left from 10 to 12 per cent. in the present refuse. The next step is diffusion, pure and simple. In this process the water put into the first vessel with the slices of cane is weight for weight the same, and takes out one-half the sugar from the first into a second vessel, containing other slices of cane, from which it takes out one-fourth the sugar into a third vessel, also holding fresh slices, and so on until in the sixth vessel the water has in solution the whole amount of sugar, excepting about 1⅙ per cent. The sugar, as it is taken out, is replaced by water in the slices of cane. By this is manifest the excess of water in diffusion juice beyond what is in mill juice. With more changes of vessel the difference would decrease, but there would always be an excess of water to be evaporated. Practical working is said to have shown this to be from 15 to 20 per cent. On the other hand, in the mill, the water imbibed by the megass previous to the second crushing is not far short of half the amount of juice contained originally in the cane, if not as much as the quantity expressed by the first pressure, and therefore an excess of from 50 to 60 per cent. What then becomes of a chief objection to diffusion, the great diluting of the cane-juice? The dilution is greater by imbibition, and yet one moiety of the sugar got by imbibition pays the cost. The other moiety is found money. Much capital is fixed in mill machinery, doubtless, and it remains to make the most of it. The greater number, by far perhaps, of planters work with borrowed money, and they are not at present likely to obtain further advances, in order to make changes or set up new apparatus. Yet the time will come for them, or new men, to try increased production, by using the most recent and approved methods and appliances. The benefit to be derived from new inventions is not always immediate or certain. But the cane-sugar producers have had the beet-sugar producers in the way before them, to bear the burden of experiment and demonstration. Cane-sugar, it will not be gainsaid, can be, even now, produced at less cost than beet-sugar. The varieties of soils yielding, some more, some less, and the diversities of mills working, some better, some worse, make it almost impossible to strike the balance of expenditure. But the make-weight on the side of the cane will be equal, it may be fairly assumed, to 2s. per cwt., the supposed bounty on beet, if not more. Nor will it be denied that there is more room for the cane than is left for the beet to develop and improve in growth and manufacture. The beet has no future to look to, in comparison with the possibilities in view of the cane.

But the cane-sugar planter and the merchant have little encouragement given them, to embark more capital and skill in the enterprise of the production, by the refiner who has the distribution of the sugar. Cane-sugar or beet-sugar, it is all "David and Davie" to the refiner. He mixes the one with the other in the manufacture of loaf or lump sugar, and says there is no difference. The mixture may even seem to be an improvement, like chiccory with coffee, to debased tastes; and unfortunately there is no pure cane lump to be had nowadays to correct the standard of taste. Beet-sugar is, nevertheless, inferior to cane-sugar in many ways. It is not equal in sweetness, the crystals are smaller, and it is of a duller, more opaque, color. To brighten up the color, the practice of "bluing" was borrowed from the laundry, and as one's linen, so the sugar is imbued with a factitious liveliness of appearance. Cane-sugar can do without this artificial aid, and the bluing might be for a sign to the consumer which of the two sugars to choose. The treacle too, or drainage, from the refined beet has not the sweet-smelling savor of that from the cane, and though in the form of golden sirup it is made enticing to the eye, it is neither so pleasing to the taste nor so wholesome as pure cane sirup. And treacle is, or was, preeminently the sweet of the children of the poor. The sugar planter has perhaps no claim on the refiner for active aid and assistance in his contest with the beet grower. But a business feeling, it might be supposed, would incline the refiner toward the exercise of a benevolent neutrality. And yet the refiner is so inconsiderate as to subsidize the common adversary of himself and the planter. For what else is it but a subsidy to give money to receive goods in aid of his trade? If the refiner will be apparently so impolitic, it is hardly reasonable in him to complain of the business going out of his power and failing him. But it is shrewdly thought that we cannot be doing a very unprofitable trade with cane-sugar at the reduced prices so long prevalent.

The conclusion of the whole matter is that we have been unable to hold our own, and have retrograded. But the supremacy that has passed into the hands of the beet-sugar producers cannot be left unchallenged. It will not be creditable to the spirit and enterprise of this country, the most deeply engaged of any in the cane-sugar industry, if the technical perfection exhibited in all the work of beet-sugar production is not attained in cane culture and manufacture. The beet-sugar cultivators and fabricant have secured a firm footing, fixed on and buttressed by the agricultural and fiscal systems of their country, but none can doubt that with a long pull, a strong pull, and a pull altogether by planter, merchant, and refiner, the tug of war would end in favor of the cane.—*Journal of the Society of Arts.*

HINTS ON THE PRESERVATION OF TYPE.*

By JAMES L. LEE, Chicago.

I AM expected to give a few hints on the preservation of type. The subject is broad, and in order to come within the time allotted I shall endeavor to give the hints and omit embellishments.

We should consider somewhat the materials used and the processes involved in the manufacture of type in order to better understand the matter, but this would require too much time, and possibly be too tedious for the present occasion.

The type is received from the foundry as shining and handsome as little bars of silver. If you would preserve it, that is, get the most wear out of it, you must begin with the lay of the case. Don't squabble it by dumping it on the stone or galley. Type frequently receives irreparable injury right at the start from being shoveled about like tenpenny nails. Forcing a rule between the lines when laying will often injure ascending and descending letters. A good way to obviate this is to provide yourself with a small wooden galley, just the size of a package of type, place the font or page of type in this, when line after line may be laid rapidly and without injury to the most delicate dot or hair line.

Uneven spacing causes a deal more harm to the face of type than is generally supposed, especially when the form is planed down in a careless way without properly loosening the quoins; the lines which are spaced tight ride up, and the planer batters them without making the form even. Speaking of planing reminds me that much type is injured through the mistaken notion of many a so-called printer that a form is a drum and he plays a rat-tat-too or a jig with mallet and planer upon its delicate face.

Another source of wear may be found in allowing type to be off its feet in the stick or galley. This throws the face of the type uneven to the platen or cylinder, as the case may be, and in order to make it print, a heavy and unequal impression becomes necessary.

Steel make-up and composing rules in the hands of careless workmen are chargeable with much damaged type. Examine carefully the ascending and descending letters, "b," "p," "d," "q," "y," etc., and if you find they are crushed and broken, you may rest assured the cruel steel has caused the mischief.

Uneven make-up of forms will cause a column to spring, and of course it receives the thrust of the impression much greater than if it were even with the rest of the form. Bending spaces and letters, a reckless subterfuge resorted to by blacksmiths in lieu of changing a 3-em for a 4-em space, or an en quad for a 3-em space to make a line justify, is death on spaces, and injures the type by throwing it off its feet. Battered and short leads and slugs are not only an annoyance to the make-up, but allow letters to slip by and ride, making it impossible to plane the form down evenly, and all high letters are battered in planing and printing.

The use of soft blankets wears out the type rapidly, as the soft and yielding pressure forces the paper into and around the letters, wearing away the hair lines and dots, and gives the type a polished and rounded appearance. A perfectly hard tympan is best of all, where type is even in height and a skilled pressman is in charge of the press; but in country offices I have found the rubber blanket the most reliable and convenient, and at the same time less injurious to type than softer substances, such as felt or cloth. This does not apply to the callous old rubber that has done duty for a decade, and is coated with ink and punched full of holes till its surface is as rough as an elephant's hide and about as fit for taking an impression on a type form. A good rubber blanket will last with care from three to five years. To obtain the best results, it is wise to use a cover of fine bleached muslin; when this becomes dirty or inky, it should be washed and ironed. Perhaps you say, "How are we to get the ink out of it?" Rub it all over with oil (lard, machine, or kerosene will do), leave the oil on all night, or longer will be better, then the ink may be readily removed with soap and water. By the way, this will be found useful in removing printer's ink from clothing.

Keeping portions of a font of type standing for the purpose of saving "fat," as we call it, in head lines, parts of legal notices, blanks, and other jobs, will materially shorten the life of the type; it soon becomes unequal in height, and in order to produce a fair print an extra pressure is necessary. Keep your type in equal use, and it will last enough longer to more than pay for the extra composition.

It has been erroneously supposed by many that a flat or platen press wears the type less than a cylinder, but such is not the case. If a cylinder press is so constructed that the bed and cylinder travel together absolutely without slip or slur, the type will last one hundred per cent. longer on it than on a platen.

A poor, weak-nosed pair of tweezers will cause sad havoc among the type; better destroy them and do without if you cannot afford a good pair. And here let me add that the form should always be loosened before attempting to correct with either tweezers, bodkin, or rule.

Sometimes, when type is new or filthy with ink and dirt, it will stick so tenaciously that it cannot be separated in the usual way between thumb and finger for distribution; the compositor bangs and thumps it on the stone until the bottom of the type is battered, and when set up again it is likely to be as unsteady on its feet as a tramp printer full of gin. If type that sticks is soaked in soap suds the battering will be unnecessary. If dirty and gummed with ink, soak in hot soap suds.

I have seen many a form seriously injured by carelessly using a worn-out lye brush. It pays to provide a good lye brush. The cost is insignificant when compared with the damage an old, smooth-faced brush will do a form of type.

In the job department, a hundred little demons combine to destroy the fragile and dainty faces of the artistic beauties in types, borders, and rules which

* Paper read before the Michigan and West Michigan Press Associations, in Traverse City, Mich.

the indefatigable founders have produced. To avoid trespassing upon your time, I will mention a few only of these destroying agents.

Did you ever notice how a new font of type is impressed into service, whether appropriate to the job in hand or not? It is new to the typo, and he thinks it must be proportionately appreciated by every customer. This not only wears out the type unnecessarily, but tires every one with its persistent appearance in and the sameness it imparts to every piece of work.

The abuse that the news type encounters is visited on job type with still greater vehemence. See that compositor distributing a line of script—the most costly type made. He throws the letters in the case with a vim that would be more appropriate pitching base ball. This destroys the delicate lines and each letter so damaged is beyond repair, and soon the font, which costs perhaps ten dollars or twenty dollars, or more, is ruined, not worn out. Give a man of that kind a dozen eggs to transfer from one basket to another and he will handle them with the greatest care, and yet a single letter of the type he bangs down so roughly is worth more than the whole dozen eggs.

The same remarks apply to the beautiful shaded letters, borders, ornaments, etc. Of course, the larger types receive most damage from this kind of treatment. Right here let me drop a word in favor of keeping large scripts and ornamental types and borders face upward in the case. This plan will be found quite as easy for distributing, a great convenience in setting, and an immense saving to the face of the type.

Job forms are damaged or mashed by using too heavy an impression to commence with. Whether a form is put on a platen or cylinder, care should be exercised to start with less tympan than necessary, bringing up the impression by adding a sheet or two as required. A type form mashed is an injury to the entire plant, and is a constant annoyance so long as a letter of it remains in the office.

The brush for cleaning job type should be soft and pliable, and, if benzine is used in a general way, it is best to wash occasionally with lye and rinse thoroughly. Never allow any lye to remain on or between the type after washing.

A word on the abuse of leads and slugs. How often we see workmen, when distributing, pile the labor-saving leads, slugs, and furniture up in a confused heap, then in handfuls bump them on the stone endwise to even them up. This batters the ends, and spreads them so that as a labor-saving article they soon become useless. A better method is to put away the leads and slugs in their order, but if one must throw them into great heaps, they should be straightened on a piece of wood furniture.

The old adage, "Familiarity breeds contempt," is as true of the printing office as elsewhere, and I have come to the conclusion that proprietors as well as employes are guilty of a great deal of abuse to the beautiful types and useful labor-saving materials and machinery which the genius of our times has perfected for their use and profit. Let the older heads here today look back a quarter of a century only and imagine, if they can, the delight the typos of that time would have experienced over the wonderful advantages of the present. An occasional glance at the *then* will often fit us to better appreciate the *now*.

DEMANGE & SATRE'S EXCAVATOR.

THIS apparatus, now in operation upon the Panama Canal, is mounted upon a strong frame of plate and angle iron, and rests upon three axles only, one of the end ones of which can be shifted laterally. This arrangement permits of more easily crossing curves of short radius. In such a case, in fact, the flange of the wheels that are keyed to the movable axle abut against the rail, and produce the desired deviation without derailing. When the curve has been passed, the axle, owing to the style of grease box used, immediately resumes its normal position.

This is a very interesting arrangement for working points where things have been prepared in haste, and where there has been no time to calculate curves with the coolness and reflection that office work permits of. For the same reason, the leveling of the roadbeds is often far from being perfect, and in order to prevent any injurious results from this fact, manufacturers provide the axle ends with a swing-bar carrying two rollers. These latter rest constantly upon a third rail laid alongside of the excavation, and distribute the load over a number of points double that which the use of a single wheel would give, this being an advantageous condition from the standpoint of stability.

In the apparatus under consideration, the bucket chain is of the usual style required of builders by the Canal Company, for the purpose of facilitating mounting and repairs during the course of the operation of this important part of the apparatus. In the excavator under consideration, it is placed in the center of the apparatus. On one side are located the engines that actuate the chain, lift the bucket frame, and move the apparatus along the track, and on the other is situated the boiler furnace. This arrangement is for a double purpose, viz., (1) to prevent ashes or dust from settling upon the working parts and causing griping while fuel is being put in or the fire raked, and (2) to separate the engineman and stoker, who thus pay better attention to their respective duties.

The boiler has a movable fire-box and a heating surface of 700 square feet.

The engine, which actuates the upper tumbler through gearings, has two equal cylinders 10 inches in diameter and of 15 inch stroke. Gearings have been preferred to the usual pitch chains, on account of the constant and inevitable stretching of the latter, and of the dangerous shocks that they have to undergo in the transmission of their stresses when a bucket meets with something hard in the ground and abruptly slips over it. This, it is true, can be remedied by special arrangements, but in this particular case the builders have preferred to totally overcome the difficulty through a recourse to gear wheels, which, it must be confessed, possess an opposite inconvenience, and that is an absolute want of elasticity in the working of the parts.

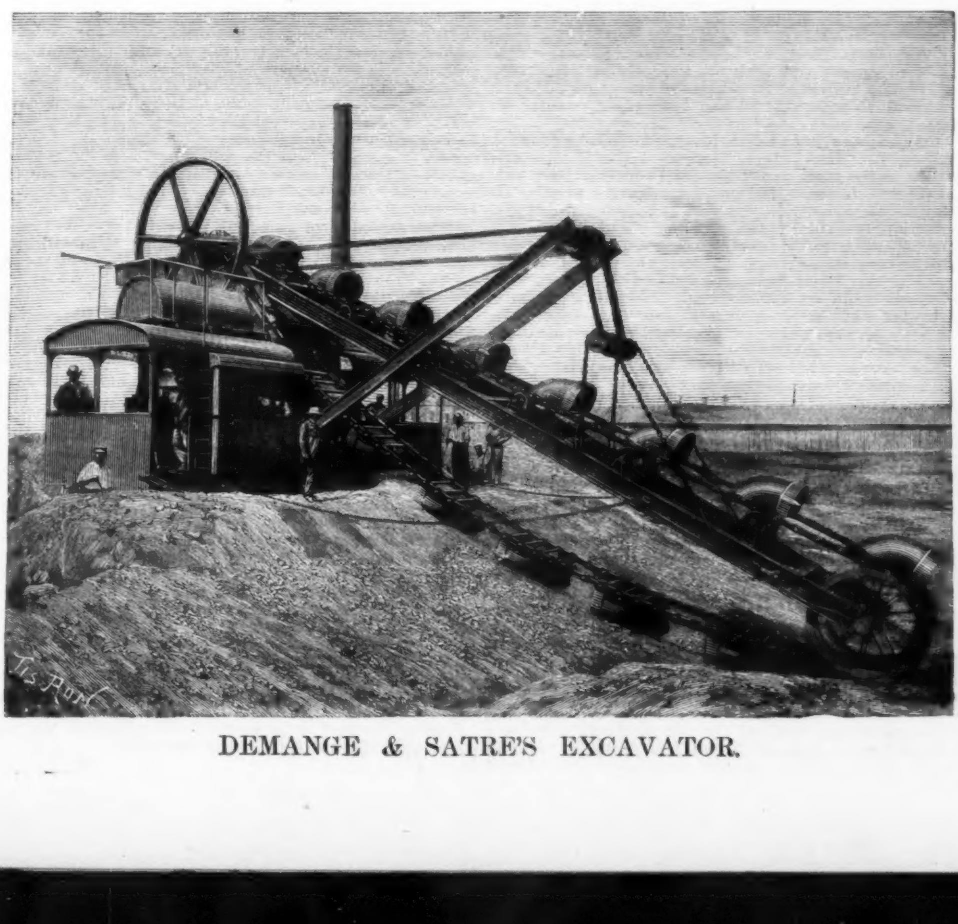
The bucket frame consists simply of two strong double T irons, and the same is the case with the crane that supports it, the builders having desired to avoid the use of thin plates, angle iron and joints.

In some analogous apparatus, delivered in 1877 to Mr. Clement, a contractor at Sainte Colombe, the builders used spring rollers under the bucket frame and rested these upon the chain, in order to force the buckets to penetrate the earth.

Conclusive experiments have proved that these rollers transmit every shock to the excavator. Moreover, the bucket chains, in hard ground, tend to incline, and one of the sides thus escapes the rollers, and the latter are wrenched out by the buckets unless the chain snaps. In the present machines, rollers have therefore been dispensed with. It is of interest to recall these tentatives, if it be merely to prevent badly inspired innovators from falling into error and finding again what has not been lost, but voluntarily and logically abandoned by practical men.

In conclusion, we may state that in the experiments made at Pantin, for the Panama Company, the performance of the apparatus furnished by Messrs. Demange & Satre exceeded the requirements of the contract by 7,060 cubic feet per hour at a velocity of 18 buckets per minute.

At a greater velocity than this, and in more favorable ground, that is to say, where the earth contained less pebbles and was not so hard in spots, the firm say that the performance of their apparatus would have exceeded the above figures by 30 per cent.—*Le Genie Civil.*



DEMANGE & SATRE'S EXCAVATOR.

APPARATUS FOR BAKERIES.

FIG. 1 of the accompanying engravings represents an apparatus for preserving yeast in bakeries. It consists of a wooden vessel to which is hermetically fitted a

FIG. 1.—APPARATUS FOR PRESERVING YEAST.

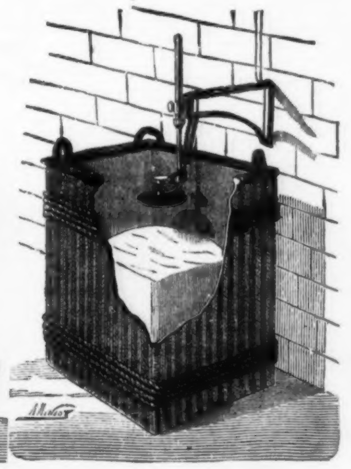


FIG. 2.—DOUGH BASKET.

cover that is provided with a hollow screw plug in the center. This latter is filled with wadding, which forms a filter and prevents organisms from entering, to the detriment of the yeast.

Fig. 2 represents a basket for the reception of dough after kneading. When the dough has risen sufficiently, the fact is announced automatically by an electric bell, which is set ringing through the contact of the upper surface of the material with a movable piston.—*Le Genie Civil.*

A NEW MOUNTING MEDIUM OF HIGH REFRACTIVE INDEX.

PROFESSOR HAMILTON L. SMITH has recently discovered a mounting medium which he regards as superior to any hitherto described. It is even superior to the preparations described in these columns in September of last year. These consisted of stannous chloride in glycerin jelly, giving a refractive index of 1·7, and of realgar in arsenic bromide, with a refractive index of 2·4. The new medium, which has a refractive index considerably above that of the stannous chloride medium, is prepared in the following manner:

Dissolve 1½ ounces of antimony bromide in two fluid drachms of a fifty per cent. solution of boro-glyceride. This, when cold, makes a very viscid medium, like old stiff balsam, of a dark sherry wine color. Mounts made with it in the extremely thin film required are as colorless as with old balsam, and when laid upon white paper the color of the medium is clearly perceptible if it has not been injured by overheating—certainly less than most mounts in styrax.

It is used precisely like Canada balsam. It works easily at a moderate heat, and boils very readily. The heat must be continued until the boiling is nearly over, but care must be observed not to overheat, as the glycerin is liable to burn. When entirely cooled, the cover will be firmly attached, as with balsam, and the slide may be cleaned with moist tissue paper, without fear of disturbing the cover.

A finishing ring may now be applied, but Prof. Smith advises that a bit of paraffin should be placed on the side, melted, and caused to flow around the mount, by tilting the preparation. A vigorous rubbing with a cloth will remove all excess of paraffin, leaving a sloping or beveled ring around the mount. This operation has preserved mounts for two months already, with no indication of change. Any finishing cement may then be applied.

The medium is only slightly deliquescent, but is decomposed by water and injured by contact with immersion fluids, hence some protection is necessary.

We now quote from Prof. Smith's letter as follows:

"The boro-glyceride which I have used was prepared for me by Mr. C. F. Booth, of Tarrant & Co., manufacturing chemists, New York. This substance is a hard, brittle, and glassy compound of glycerin and boracic acid, and will no doubt serve an excellent purpose as a mounting material from its antiseptic properties. I use a 50 per cent. solution of this in glycerin.

"I wish to say here that recently, in looking over some of my earliest mounts, in the chloride of tin and glycerin medium, that I had thrown aside because of leakage (as this material, before I used gelatin, always remained more or less soft, and so made it difficult to clean off the cover before ringing), I was surprised to find that not only had the leakage stopped, but that the drop outside was indurated, and when removed the whole seemed perfectly sealed and showed no tendency to the smearing when wiped hard, that had caused me at first to suppose these mounts were spoiled, and they

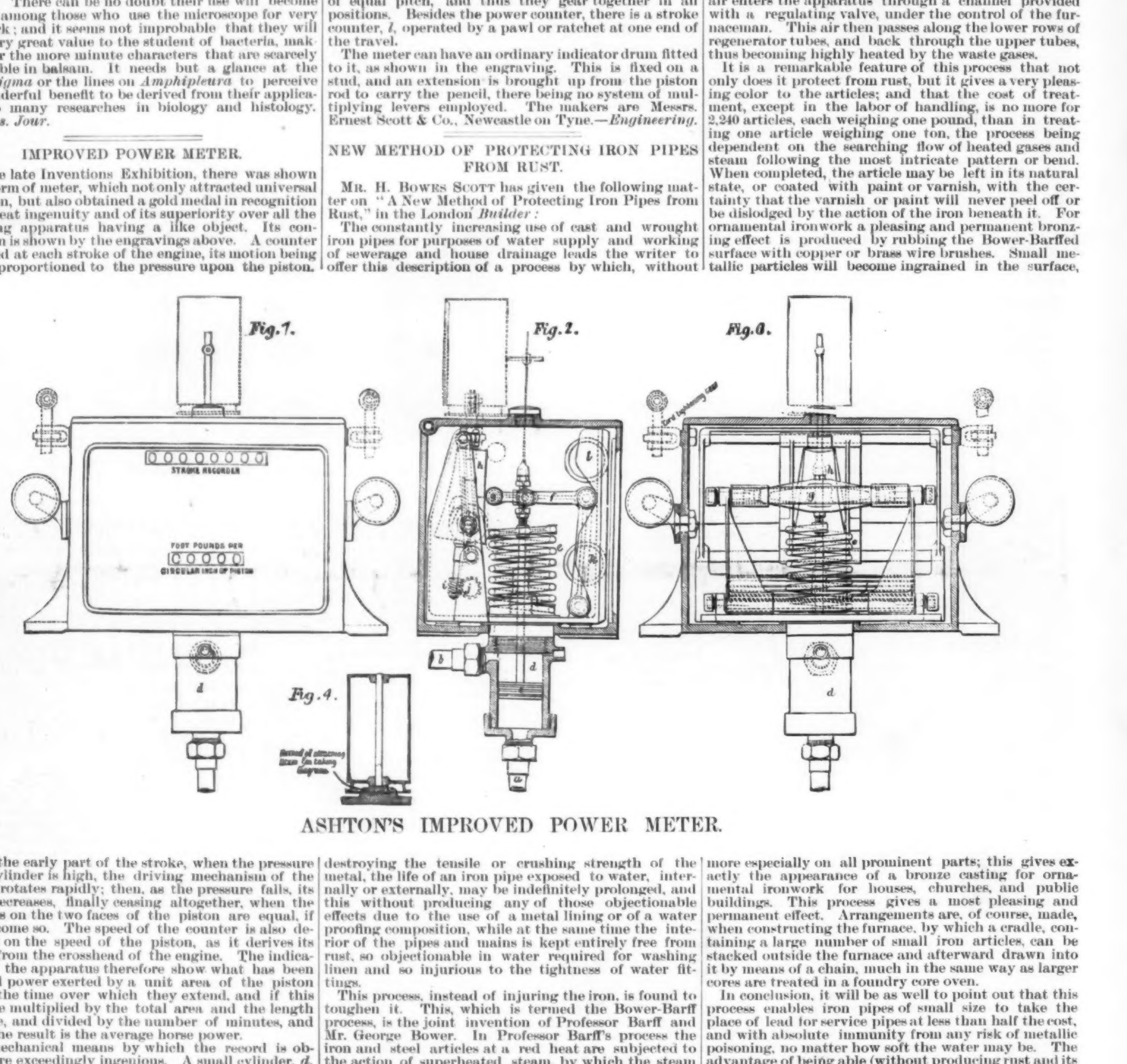
remain up to the present moment now apparently good. The boro-glyceride 50 per cent. solution will not permit as much chloride of tin to be dissolved as I mentioned in the directions for the gelatin preparation in the September number. A 25 or 30 per cent. solution will be better here, and this medium still answers admirably for ordinary diatoms.

"The gelatin and tin compound is more hygroscopic than the compound of boro glyceride and antimony; still, if properly made and used, will answer admirably and remain unchanged, I believe, for any length of time."

The value of these mounting media is not easily overestimated. They are not yet in general use, and have not been applied to many scientific investigations. They are not even in the market, and this may be a hint to some of our readers who may wish to make their microscopical work a source of some profit, for there should be a demand for the media among the dealers. There can be no doubt their use will become general among those who use the microscope for very fine work; and it seems not improbable that they will be of very great value to the student of bacteria, making clear the more minute characters that are scarcely discernible in balsam. It needs but a glance at the *Pleurosigma* or the lines on *Amphipleura* to perceive the wonderful benefit to be derived from their application to many researches in biology and histology.—*Micros. Jour.*

IMPROVED POWER METER.

At the late Inventions Exhibition, there was shown a new form of meter, which not only attracted universal attention, but also obtained a gold medal in recognition of its great ingenuity and of its superiority over all the preceding apparatus having a like object. Its construction is shown by the engravings above. A counter is rotated at each stroke of the engine, its motion being exactly proportioned to the pressure upon the piston.



ASHTON'S IMPROVED POWER METER.

During the early part of the stroke, when the pressure in the cylinder is high, the driving mechanism of the counter rotates rapidly; then, as the pressure falls, its speed decreases, finally ceasing altogether, when the pressures on the two faces of the piston are equal, if they become so. The speed of the counter is also dependent on the speed of the piston, as it derives its motion from the crosshead of the engine. The indications of the apparatus therefore show what has been the total power exerted by a unit area of the piston during the time over which they extend, and if this power be multiplied by the total area and the length of stroke, and divided by the number of minutes, and 33,000, the result is the average horse power.

The mechanical means by which the record is obtained are exceedingly ingenious. A small cylinder, *d*, is connected at its ends by two pipes, *a* and *b*, to the two ends of the cylinder of the engine which is to be tested. It contains a piston, *c*, which is thus exposed to the same pressures on its two faces as the main piston. The piston-rod is coupled to a spring, *e*, the movements of which are a measure of the resultant pressure on the piston, *c*. In the illustration the spring and the piston are both shown in the mid or zero position, and they can rise or fall accordingly as the pressure is greater in the upper or lower part of the cylinder, *d*. The crosshead of the piston rod is coupled to a swinging frame, *f*, which is supported at one end by the radius bars, *k*. At the other end it carries a roller, *g*, of considerable length. This roller always stands in contact with a hyperbolic conoidal drum, *h*, mounted on a nearly vertical spindle; the roller does not always touch the drum at the same point, for it is constrained to rise and fall with the piston, and thus sometimes it is in contact with the upper and smaller part of the drum, and sometimes with the lower and larger part. To the drum spindle there is imparted a translatory reciprocating motion, which is an exact representation, to a reduced scale, of the motion of the piston of the engine. The drum is thus carried backward and forward in contact with the roller, and as the two are covered with teeth, the drum is rotated first in one direction and then in the other, the amount of rotation depending upon the position of the roller. Upon the drum spindle there is a worm, *i*, which gears with a wormwheel, *j*. This wormwheel is very broad, so that the worm never comes out of gear with it, although it is moved laterally with the drum; further, the angle of rifling of the teeth is such that when the roller, *g*, stands at its mid or zero position, no motion is communicated from the drum to the wormwheel. The drum rotates and carries with it the worm, but the amount of motion of the wormwheel is exactly equal and opposite to that which it receives by the worm being displaced sideways, and thus the resultant effect upon it is *nil*. At every other position of the roller, *g*, the wheel, *j*, is rotated, and always in the same direction. On one stroke of the engine the worm runs rapidly in one direction and turns the wheel, and on the other stroke it rotates slowly in the opposite direction, still turning the wheel in the same sense, the resultant of the motions of rotation and translation being always to move the counter forward when work is being done by the engine.

The roller, *g*, and drum, *h*, are both covered with teeth of equal pitch, and thus they gear together in all positions. Besides the power counter, there is a stroke counter, *l*, operated by a pawl or ratchet at one end of the travel.

The meter can have an ordinary indicator drum fitted to it, as shown in the engraving. This is fixed on a stud, and an extension is brought up from the piston rod to carry the pencil, there being no system of multiplying levers employed. The makers are Messrs. Ernest Scott & Co., Newcastle on Tyne.—*Engineering.*

NEW METHOD OF PROTECTING IRON PIPES FROM RUST.

Mr. H. Bowes Scott has given the following matter on "A New Method of Protecting Iron Pipes from Rust," in the London *Builder*:

The constantly increasing use of cast and wrought iron pipes for purposes of water supply and working of sewerage and house drainage leads the writer to offer this description of a process by which, without destroying the tensile or crushing strength of the metal, the life of an iron pipe exposed to water, internally or externally, may be indefinitely prolonged, and this without producing any of those objectionable effects due to the use of a metal lining or of a water proofing composition, while at the same time the interior of the pipes and mains is kept entirely free from rust, so objectionable in water required for washing linen and so injurious to the tightness of water fittings.

This process, instead of injuring the iron, is found to toughen it. This, which is termed the Bower-Barff process, is the joint invention of Professor Barff and Mr. George Bower. In Professor Barff's process the iron and steel articles at a red heat are subjected to the action of superheated steam, by which the steam is decomposed, and the oxygen combines with the iron, forming magnetic oxide. The Bower process consists in submitting the metals at a red heat to the action of ordinary air and carbonic acid gas, produced by the combustion of carbonic oxide inside the chamber in which the articles are treated. The Barff process is direct and continuous, and forms the magnetic oxide directly by the decomposition of water. The Bower-Barff process is intermittent, the magnetic oxide being formed by a series of oxidizing and deoxidizing operations.

The process now under consideration is a combination of the two. It is being carried out at works in London and the provinces. The chemical description of the process is as follows: The excess of oxygen in the furnace in the first place produces Fe_2O_3, or sesquioxide of iron, and the under surface of this being in contact with metallic iron undergoes reduction to magnetic oxide in the following manner: Four equivalents of sesquioxide unite with one of metallic iron, forming three equivalents of magnetic oxide, or symbolically (3) $4\,Fe_2O_3 + Fe = Fe_3O_4$. The furnaces can be made of various sizes. Some in use are of the following dimensions: 36 feet long, 6 feet 6 inches wide, and 6 feet high; others are 13 feet by 4 feet 3 inches by 4 feet 3 inches. They are built of fire-brick, supported and strengthened by ordinary T or channel iron. The gas-producers are three or more closed hearths, each provided with a hopper above for the admission of fuel—the fuel used is a non-coking gas coal; of this about 7 cwt. per day is sufficient for a furnace 13 feet long by 4 feet 3 inches high. Anthracite can be used equally effectively, if petroleum at the rate of about a gallon per hour is dropped into the gas producer. The carbonic oxide, from the combustion of the fuel in the producers, passes along a conduit, under the control of a sliding door, to the openings, where it meets heated air ascending, and is consumed. The products of combustion, after being mixed with steam from a boiler at about 20 pounds pressure, are then conducted along a passage packed with open built fire brick walls at intervals; by them they are thoroughly mixed; they then return along another and lower passage, and enter by means of narrow oblong holes the chamber, or furnace proper, in which the iron articles to be treated are placed. After having passed over and among these, the waste gases escape downward through ports into the regenerator chamber, and thence to the chimney flue, heating in its passage the fire clay tubes composing the regenerator, which are supported by cross walls. Cold air enters the apparatus through a channel provided with a regulating valve, under the control of the furnaceman. This air then passes along the lower rows of regenerator tubes, and back through the upper tubes, thus becoming highly heated by the waste gases.

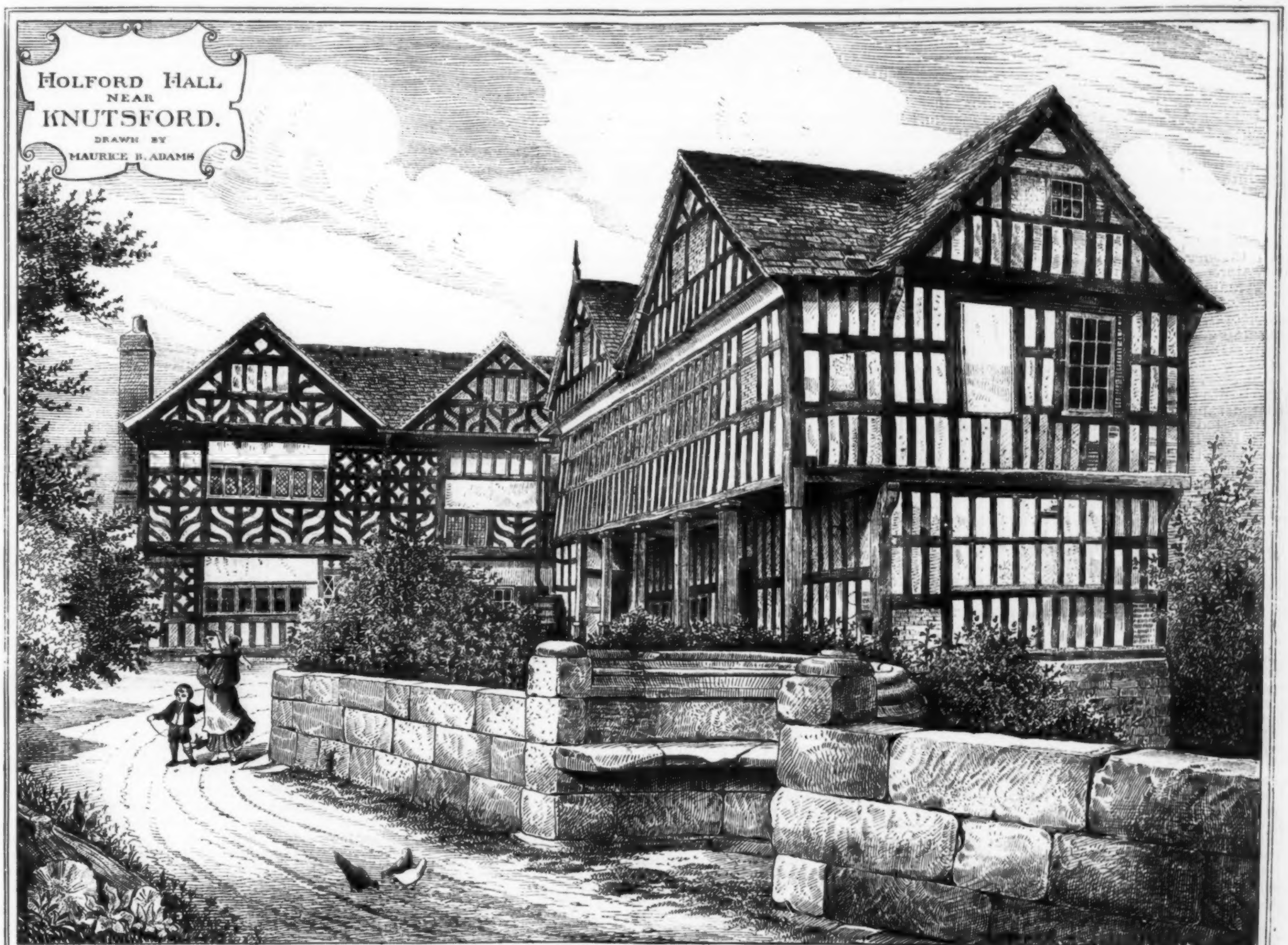
It is a remarkable feature of this process that not only does it protect from rust, but it gives a very pleasing color to the articles; and that the cost of treatment, except in the labor of handling, is no more for 2,240 articles, each weighing one pound, than in treating one article weighing one ton, the process being dependent on the searching flow of heated gases and steam following the most intricate pattern or bend. When completed, the article may be left in its natural state, or coated with paint or varnish, with the certainty that the varnish or paint will never peel off or be dislodged by the action of the iron beneath it. For ornamental ironwork a pleasing and permanent bronzing effect is produced by rubbing the Bower-Barffed surface with copper or brass wire brushes. Small metallic particles will become ingrained in the surface, more especially on all prominent parts; this gives exactly the appearance of a bronze casting for ornamental ironwork for houses, churches, and public buildings. This process gives a most pleasing and permanent effect. Arrangements are, of course, made, when constructing the furnace, by which a cradle, containing a large number of small iron articles, can be stacked outside the furnace and afterward drawn into it by means of a chain, much in the same way as larger cores are treated in a foundry core oven.

In conclusion, it will be as well to point out that this process enables iron pipes of small size to take the place of lead for service pipes at less than half the cost, and with absolute immunity from any risk of metallic poisoning, no matter how soft the water may be. The advantage of being able (without producing rust and its attendant disadvantages) to construct all service pipes and joints of the stronger and cheaper material scarcely requires pointing out; this is more especially the case in districts where pressure is high and where the system of supply is constant. There are in this country alone vast numbers of villages without any adequate water supply. Many of these are from time to time adopting gravitation and even pumping schemes, the water being supplied by stand pipes, and only rarely being brought into the cottages in consequence of the expense. These villages might have the supply taken into every cottage at an expense only slightly in excess of the cost of stand pipes if wrought iron Bower-Barffed pipes were adopted, while the comparative merit of the scheme, which brings the water into the house rather than leaving it to be carried, scarcely requires drawing attention to. The increasing use of iron for soil pipes and house drains opens another and a large field for the Bower-Barff process. The advantage of preserving the interior of the soil pipe somewhat cannot be overrated. This has hitherto been difficult to insure, as the ordinary iron pipe has been very liable to rust and corrode.

Canadian lumber dealers are now glad to buy the black walnut fence rails which farmers split and used as they would any other timber twenty or thirty years ago. The long exposure has seasoned the wood thoroughly, and it is valuable as material for chair legs, spindles, and other small articles.

THE DISINFECTION OF CATTLE CARS BY SUPERHEATED STEAM.

IN France and upon a large number of foreign lines, the disinfection of cars that have been used in the transportation of cattle is accomplished in the following manner: The sides and floor of the car are carefully cleaned and scraped and are washed with a liquid antiseptic composed of phenic acid, chloride of zinc, sulphate of zinc, or one or two per cent. of chlorine. In other countries, especially in Germany and Austria and in Russia, they have abandoned the use of chemical substances upon some of the lines, and use steam of high pressure taken from the boiler, which they project upon the sides of the car. This method is very efficacious. Dr. Redard, a physician in chief of the French railroads, has already given careful attention to the question. He has reached the conclusion, after a number of experiments, that, in the matter of the disinfection of cars contaminated by the transportation of sick animals, phenic acid, chloride of zinc, and the sulphate of zinc, and the nitrosulphate of zinc, and sulphur, employed under these conditions, as they are to-day, are absolutely without any effect upon the germs, and that the method of disinfection of cars by chemical substances is useless and inefficacious, and, also, that disinfection practiced with damp steam whose temperature does not exceed 212° F. is also useless. In the course of new experiments, the result of which has been entirely satisfactory, Dr. Redard affirms the efficacy and recommends the use of disinfection by steam superheated to 230°. The process is extremely simple and not at all expensive. It has just been experimented with upon the State railroads of France. It consists in the employment of a coil placed at a convenient distance from the boiler of the locomotive, and allowing the passage of the steam through an apparatus of extremely high temperature. The coil is formed of an iron tube eight-tenths of an inch in inside diameter and one-twelfth of an inch thick; it has a total length of 2,800 feet. The part directly exposed to the action of the heat presents a heating surface of seven square feet. It is formed of seven spirals of seven inches outside diameter; one of these has on its extremity a steam cock, and another has a swivel joint that allows the steam to be conducted to the car by means of a flexible pipe. The swivel joint is entirely composed of metal, and consists of ten parts, articulated together, 39 inches long, five-eighths of an inch inside diameter, and one-sixteenth of an inch thick. It ends in a kind of lance, formed in the shape of a T; the outlet is formed of six slots about 4 inches long; their size decreases from the center to the extremities; they are about one thirty-second of an inch wide at the center and one sixty-fourth of an inch at the two extremities. With a little precaution they have succeeded in obtaining, for the space of several hours' duration, an absolutely constant pressure of steam at 230°. At this temperature the jets of steam are projected upon the interior of the car and thoroughly destroy all germs. We are indebted for these particulars to the report of the Minister of Public Works.—*Amer. Jour. Ry. Appli.*



HALF-TIMBERED OLD MANOR-HOUSE.

HOLFORD HALL, NEAR KNUTSFORD.

THIS half-timbered old manor-house, here drawn from a photograph, is one of the many similar buildings for which Cheshire is so famous. It stands near Plumley Station, in the Bucklow Hundred of Mid-Cheshire, on the line between Northwich and Knutsford, some seventeen miles from the last named ancient town, and Tabley Old Hall (the celebrated brick-built house of the De Tableys, which was designed for them by Carr, of York) is a near neighbor. The river Poever Eye runs close by Holford, and just below the hall joins Waterless Brook. Curious writers and local historians tell us that the name of the mansion is due to its situation, which rejoices in the antique, if not the euphonious, cognomen of "Derne Hole." The derivation is thus given: "Holford means ford in a hole, or else is taken from the old word 'Hale,' which we now call Hall, and so denotes as much as a ford under the Hall; or possibly it is derived from the word Holt—a wood—quasi Holt-Fora, the ford here being anciently environed with a wood." Whether the ford did actually run under the house or not is scarcely, perhaps, a point of much importance now; but certainly the place was moated, and a massively constructed stone bridge formed the only means of approach to the building, as will be seen by the view which we publish to-day. One of the seats in the recesses of the sides of the bridge wall is shown to the front of the picture. The house, which once inclosed a quadrangle on three sides, has long been neglected, and part of the original structure has gone entirely. The two wings still standing are now occupied as a farmhouse. In its palmy days the piazza facing the old courtyard or quadrangle was, doubtless, the scene of many a gay gathering and fashionable entertainment when the Dowager Lady Mary Cholmondley, whom King James nicknamed "The bold Lady of Cheshire," resided here, and set the fashions for the neighborhood. The "Acorus Calamus," or the sweet flag, which Ray tells us still survives here in the moat, was, doubtless, grown to strew the floors of the manor-house with, according to the old custom, which was thought the height of elegant refinement. The rush gave off a strong aromatic bouquet, and this was considered to be particularly agreeable. Sand frequently was also used for the same purpose, no doubt; but the chief attraction of its use was necessarily confined to its cleanliness and color, neat patterns and clever devices being employed to set off the flooring. The practice still prevails in this neighborhood in a few farmhouses and cottages; while on the occasion of marriages the old custom is preserved to this day of strewing colored sands on the roadway which forms the bridal path to be traversed by the newly married pair. The walls of the mansion are entirely constructed of timber and plaster, erected on a stone-built base, which runs down to varying levels to suit the site. Many alterations and changes of occupation have left their conspicuous marks upon the exterior, chiefly in the way of blocked-up windows and later insertions for light.

The upper parts overhang, and here and there look very tottery, either bulging out or sinking inward most picturesquely. Formerly Holford, which "lieth part in Plumley and part in Lostock-Graham," belonged to the abbey of St. Werburge at Chester; but at the Dissolution the property was bought by Roger Manwaring, of Carincham. Descending from the Tofts, the place owned its origin to Hugh de Runchamp, Lord of Lostock, whose connection with the place may be read in the history of the county. Roger de Holford was the son and heir of William Toft and Joan Lostock, his wife, in the year 1316. He assumed the name of his estate soon after becoming possessed of it, in obedience to the fashion of the period, and his posterity retained his adopted surname of Holford. The Holfords of Holford continued to hold the property till the time when Lady Cholmondley fought her memorable long lawsuits over the Holford lands with George Holford, of Newborough, in Dutton, keeping up the contest with the timely aid of lawyers for no less a period than 40 years, when at last her family, worn out by the fight and impoverished by its costliness, stepped in between the "bold Lady of Cheshire" and her antagonist, and divided the lands between them. Holford manor was given to "her ladyship" with the "demain lands." She is recorded to have rebuilt and enlarged the house, and she died there in 1625. The house is better known as the historic home of the Cholmondleys, although its name still reminds us of its earlier occupation by the Holfords of Holford Hall.—*Building News.*

CUTTING AND RESURFACING OUR WOOD PAVEMENT.

SOME interesting experiments have been lately made with a view to cutting and resurfacing wood pavements that are already said to have become uneven through excessive wear or other causes. The machine is the invention of Mr. Arthur C. Bicknell, of the Sandycroft Foundry Company, Chester; in appearance it is not unlike an ordinary traction engine, propelling itself and carrying in front of it a large revolving horizontal head fitted with cutters and driven by friction gearing. The experiments have been carried out in Manchester; a number of old wooden blocks that had been taken up from a worn-out road, and were full of stones and grit, were obtained from the Improved Wood Pavement Company in London, and were relaid in concrete and fitted in with cement and sand, the usual method of making a road. A week was then allowed for the cement to thoroughly set before the cutting head was applied, the surface was then taken off, the cuts varying from ½ in. to 3 in. in depth; the deeper the cut, the better the machine appeared to work, the cutters getting below the grit and stones on the surface. The speed at which the cutting head advanced was about 1 ft. a minute. It is expected that further experiments will be made and that the machine will eventually come into general use, thus making locomotion more agreeable, prolonging the life of our roads and lessening the vexatious stoppage and delay to traffic that so frequently occurs when roads that are really only half worn out have to be taken up and entirely relaid.

UNDERGROUND TEMPERATURES.

THE committee appointed for the purpose of investigating the rate of increase of underground temperature downward in various localities of dry land and under water have recently issued their seventeenth report (for the two years since the summer of 1883), which has been drawn up by Professor Everett, the secretary of the committee.

The report opens with an account of some observations made in the deep bore-hole of the waterworks at Richmond (Surrey), by Mr. Collett Homersham, C.E., under whose supervision the boring operations have been conducted for the Select Vestry. The bore-hole is on the right bank of the Thames, and about 33 yards from high-water mark. The surface is 17 ft. above Ordnance datum. The upper part consists of a well 253 ft. deep (having an internal diameter of 7 ft. at top and 5 ft. at bottom), which was sunk in 1876 for the purpose of supplying the town with water, and was carried down to the chalk. From the bottom of the well a 24 in. bore-hole was sunk to the total depth of 434 ft.; thus penetrating 181 ft. into the chalk. This portion of the work was completed in 1877. Above the chalk were tertiaries, consisting of 160 ft. of London clay, 60 ft. of the Woolwich and Reading beds, and some underlying sands. The water yielded at this stage was about 160 gallons per minute; and, when not depressed by pumping, was able to rise four or five feet above the surface. Its ordinary level, owing to pumping, was about 130 ft. lower. In 1881 the Richmond Vestry determined to carry the bore-hole to a much greater depth, and the deepening has been executed under the direction of Mr. Homersham. The existing bore-hole was first enlarged and straightened, to enable a line of cast-iron pipes, with an internal diameter of $16\frac{1}{2}$ in., having the lower end driven water tight into the chalk at a depth of 438 ft., to be carried up to the surface. The total thickness of the chalk was 671 ft. Below this was the upper greensand, 16 ft. thick; then the gault clay, $201\frac{1}{2}$ ft. thick, then 10 ft. of a sandy rock, and a thin layer of phosphatic nodules. Down to this point the new boring had not yielded any water. Then followed a bed $87\frac{1}{2}$ ft. thick, consisting mainly of hard oolitic limestone. Two small springs of water were met with in this bed, at the depths of 1,203 and 1,210 ft.; the yield at the surface being $1\frac{1}{4}$ gallons a minute, with power to rise in a tube and overflow 49 ft. above the ground. A partial analysis of this limestone rock showed it to contain 2·4 per cent. of sulphide of iron in the form of pyrites. At the depth of 1,239 ft. this limestone rock ended, and hard red sandstone was found, alternating with beds of variegated sandy marl or clay. After the depth of 1,253 ft. had been attained, the yield of water steadily increased as the boring was deepened; the overflow at the surface being two gallons a minute at 1,254 ft., eight gallons at 1,363 ft., and eleven gallons at 1,387 ft. It rose to the top of a tube carried 49 ft. above the surface, and overflowed; and a pressure gauge showed that it had power to rise 126 feet above the surface. The diameter of the bore was $16\frac{1}{4}$ in. in the chalk, $13\frac{1}{2}$ in. in the gault, $11\frac{1}{4}$ in. in the oolitic limestone, and at the depth of 1,334 ft. it was reduced to a little less than 9 in. At 1,337 ft. the method of boring was changed; and, instead of an annular arrangement of steel cutters, a rotary diamond rock-boring machine was employed. The bore-hole, with a diameter of $8\frac{1}{4}$ in., was thus carried down to $1,367\frac{1}{2}$ ft., at which depth, lining tubes having to be inserted, the diameter was reduced to $7\frac{1}{4}$ in.; and this size was continued to 1,447 ft., at which depth the boring was stopped. The bore-hole was lined with strong iron tubes down to the depth of 1,364 ft.; and those portions of the tubes that are in proximity to the depths where water was struck were drilled with holes to admit the water into them. Three observations of temperature taken with an inverted Negretti maximum at the depth of 1,337 ft., when the bore-hole was full of water, recorded $75\frac{1}{2}$° Fahr. In the first observation (on March 25, 1884) the thermometer was left for $1\frac{1}{4}$ hours at the bottom of the bore-hole, and three weeks had elapsed since the water was disturbed by boring. The second observation was taken on March 31, when the thermometer was $5\frac{1}{2}$ hours at the bottom. In the third observation special precautions were taken to prevent convection. The thermometer was fixed inside a wrought iron tube, 5 ft. long, open at the bottom. The thermometer was near the lower end of the tube, and was suspended from a water tight wooden plug, tightly driven into the tube. There was a space of several inches between the plug and the thermometer, and this part of the tube was pierced with numerous holes, to allow the escape of any cold water which might be carried down by the tube. The tube was one of a series of hollow boring-rods used in working the diamond-drill machine. By means of these it was lowered very slowly, to avoid disturbance of the water as much as possible; and the tube containing the thermometer was gradually worked through the sand at the bottom of the bore-hole. The lowering occupied five hours, and was completed at noon on Saturday, June 7. Cement, mixed with sugar, for the purpose of slow setting, was immediately lowered on to the surface of the sand, and above this a mixture of cement and sand, making a total thickness of 3 or 4 ft. of cement plugging. The thermometer was left in its place for three full days, the operation of raising being commenced at noon of Tuesday, June 10, and completed at 5 P. M. The thermometer again registered $75\frac{1}{2}$° Fahr.—exactly the same as in the two previous observations which were taken without plugging. It would therefore appear that the steady up-flow of water in the lower part of the bore prevents any downward convection of colder water from above. The boring has since been carried to the depth of 1,447 ft., with a diameter reduced to $7\frac{1}{8}$ in., and Mr. Homersham lowered the thermometer to the bottom without plugging. It remained down for six days (February 3 to 9, 1885), and gave a reading of $76\frac{3}{4}$° Fahr. The water overflowing at the surface had a temperature of 59° Fahr. To deduce the mean rate of increase downward, a surface temperature of 50° Fahr. is assumed. This gives for the first 1,337 ft. an increase of $25\frac{1}{2}$°, which is at the rate of 1° Fahr. in 52·4 ft., and for the whole 1,447 ft. an increase of $26\frac{3}{4}$°, which is at the rate of 1° Fahr. in 54·1 ft. These results agree with the Kentish Town well, where Mr. Symons found in 1,100 ft. an average increase of 1° in 55 ft.

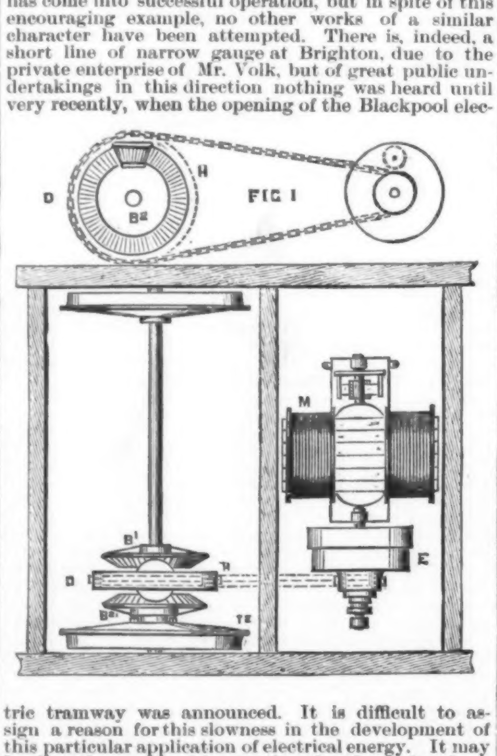
Mr. Galloway has furnished observations taken during the sinking of a shaft to the depth of 1,272 ft. in or near the Aberdare Valley, Glamorganshire. The position of the shaft is on the slope on the east side of the valley, about midway between the bottom of the valley and the summit of the hill which separates it from the Merthyr Valley. The mouth of the shaft is about 800 ft. above sea level.

Observations were taken at four different depths, 546 ft., 780 ft., 1,020 ft., and 1,272 ft., the thermometer being in each case inserted, and left for 24 hours, in a hole bored to the depth of 30 in. at a distance not exceeding $2\frac{1}{2}$ yds. from the bottom of the shaft for the time being. About eight hours elapsed between the completion of the hole and the insertion of the thermometer. The strata consist mainly of shales and sandstone, with a dip of 1 in 12, and the flow of water into the shaft was about 250 gallons per hour. The first of the four observations was taken in the fire-clay under the Abergorkie vein; the second in strong "clift" (a local name for argillaceous shale) in disturbed ground; the third in bastard fire-clay under a small rider of coal previously unknown; the fourth in "clift" ground 2 yds above the red-ash vein which overlies the 9 ft. seam at a height of from 9 to 12 yds. The observations were as follows: At 546 ft., 56° Fahr.; 780 ft., $59\frac{1}{2}$° Fahr.; 1,020 ft., 63° Fahr.; 1,272 ft., $66\frac{1}{2}$° Fahr. Comparing consecutive depths from 546 ft. downward, we have the following increments of temperature: $3\frac{1}{2}$° in 234 ft., giving 1° for 67 ft.; $3\frac{1}{2}$° in 240 ft., giving 1° for 69 ft.; $3\frac{1}{2}$° in 252 ft., giving 1° for 72 ft. They show a remarkably regular rate of increase. A comparison of the first and fourth observations gives an increase of $10\frac{1}{2}$° in 726 ft., which is at the rate of 1° Fahr. in 69·1 ft. As a check upon this result, the committee find that this rate of decrease reckoned upward from the smallest depth (546 ft.) would give a surface temperature of (56·0 — 7·9 =) 48·1°, which, as the elevation is 800 ft., is probably very near the truth.

Mr. Garside has sent an observation of temperature taken by himself in the roof of the Mersey Tunnel, in August, 1883. The temperature was 53°, the depth below Ordnance datum being 92 ft. A great quantity of water from the river was percolating through the sides of the tunnel. On August 13, 1854, he verified his previous observation in Denton Colliery (given in the committee's fifteenth report). The second observation was made at the same depth as the first (1,317 ft.), in the same pit and level, and under the same circumstances, except that the thermometer was allowed to remain 14 days instead of only six hours in the hole bored for it. The temperature observed was the same as before, viz., 66°. Mr. Garside has also supplemented his previous contribution to our knowledge of the surface temperature of the ground in the East Manchester coal-field by two more years' results from the same observing stations. The difference between them agrees well with the generally accepted rate of 1° for 300 ft., and indicates about 48° as the surface temperature at small elevations, such as 30 ft. The pits in the East Manchester coal fields, from which we have observations, viz., Astley Pit (Dukinfield), Ashton Moss, Bredbury, Denton, and Nook Pit, are all sunk in ground at elevations of between 300 and 350 ft. It would therefore appear that the assumption of a surface temperature of 49°, which we made in reducing these observations, is about 2° in excess of the truth. A very elaborate paper on "Underground Temperatures" has recently been communicated to the Royal Society by Professor Prestwich. He is disposed to adopt 1° Fahr. in 45 ft. as the most probable value of the normal gradient.

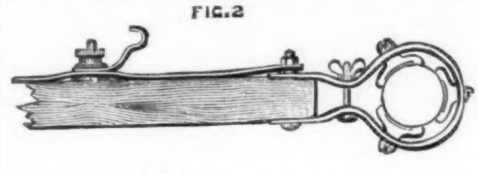
THE BLACKPOOL ELECTRIC TRAMWAYS.

THE development of electric locomotion has progressed very slowly in this country. It is now over two years since Mr. Traill's electric railway at Portrush has come into successful operation, but in spite of this encouraging example, no other works of a similar character have been attempted. There is, indeed, a short line of narrow gauge at Brighton, due to the private enterprise of Mr. Volk, but of great public undertakings in this direction nothing was heard until very recently, when the opening of the Blackpool elec-



tric tramway was announced. It is difficult to assign a reason for this slowness in the development of this particular application of electrical energy. It may be that the means of locomotion already at hand are so abundant as to render any new enterprise in this direction of secondary importance, or it may be that the check experienced by the electric lighting industry has reacted also upon other applications of electricity, and thrown financial difficulties into the way of all things connected with it; the fact remains that we in this country are in this respect not only behind our cousins on the other side of the Atlantic, but also behind the Continent. At the time when the Portrush Railway approached completion, there were in Germany and Austria alone the following electric railways already in use: (1) Lichterfelde near Berlin, $1\frac{1}{2}$ miles; (2) Mödling near Vienna, 2 miles; (3) Frankfurt-Offenbach, $4\frac{1}{8}$ miles; (4) Zaukerode Mine, $\frac{3}{8}$ mile; (5) Hohenzollern Mine, $\frac{1}{2}$ mile; (6) Neu Stassfurt Mine, $\frac{3}{8}$ mile. Two systems of electric tramways were shown at the late Inventions Exhibition, which may be considered as fairly typical of the general problem. In one system, each tram-car carries its own store of power with it, and is thus independent of any electrical connection along the road; in the other system, the electrical energy is conveyed to the car by means of a conductor laid along the line. The former system was exemplified by a small working model of a tramcar constructed on Mr.

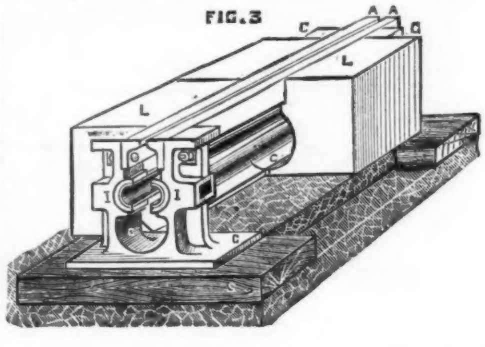
FIG. 2



Reckenzaun's principle, and provided with two of his motors and with storage cells, while the latter system was shown on a working scale by one of Mr. Holroyd Smith's cars, which conveyed passengers along the South Promenade. For the present, we shall describe the tramway erected at Blackpool on the plans of Mr. Holroyd Smith.

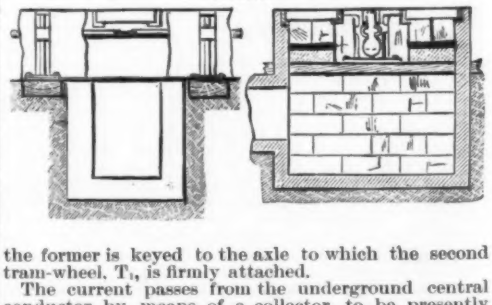
Mr. Holroyd Smith has described his experiments from time to time in papers read before the British Association, the first communication being made as early as September, 1883. In this he described experiments undertaken to ascertain the superiority of large over small driving wheels. A short length of track of 2 ft. 9 in. gauge was laid in a warehouse, and a trolley having one large center wheel and two small side wheels was placed on it. The center wheel, 3 ft. in diameter and 6 in. wide, ran on two broad wooden rails with a slot between them, through which an arm passed for the purpose of making electrical connection with a continuous conductor placed underneath. The side wheels were 12 in. in diameter, and ran on angle iron rails. The trolley weighed exactly half a ton, and this weight was so distributed that 5 cwt. came on the center wheel and 5 cwt. on the two side wheels. Both axles were fitted with gear, so that either could be revolved. A rope was attached to the trolley and let over a pulley fixed to the ground, and thence over

FIG. 3



another pulley fixed to a beam above. Weights were attached to the end of the rope until the wheels began to slip, and it was thus found that the large wheel had more than three times the tractive force of the small wheels. A similar car, but of narrower gauge, was then built, and propelled by a Siemens dynamo acting through two sets of spur gear on to the large wheel. The current was generated by another dynamo, and conveyed along the line by two conductors consisting of angle iron and copper wire placed on insulators in a central underground trough. The next experimental line was laid in a field near the works of Messrs. Smith, Baker & Co., of Manchester, and consisted of a track 4 ft. $8\frac{1}{2}$ in. gauge, 110 yards long. A full-sized street tramcar was constructed for it, and since the immediate object of the experiments was to obtain data applicable to a tramway line where no steep gradients occurred, the center wheel was abandoned, sufficient tractive force being obtained by the ordinary tramcar wheels. To provide for sharp curves, the driving axle was provided with differential gear as shown in Fig. 1, which is a sketch plan. M is a Siemens motor running at 650 revolutions per minute, E is a combination of box-gearing, friction clutch, and chain pinion, the steel chain passing on to the chain wheel, H, which is free to revolve on the axle, and which carries a differential pinion gearing with the bevel wheels, B_1 B_2. The latter is keyed to the sleeve of the loose tram-wheel, T_2, while

FIG. 4

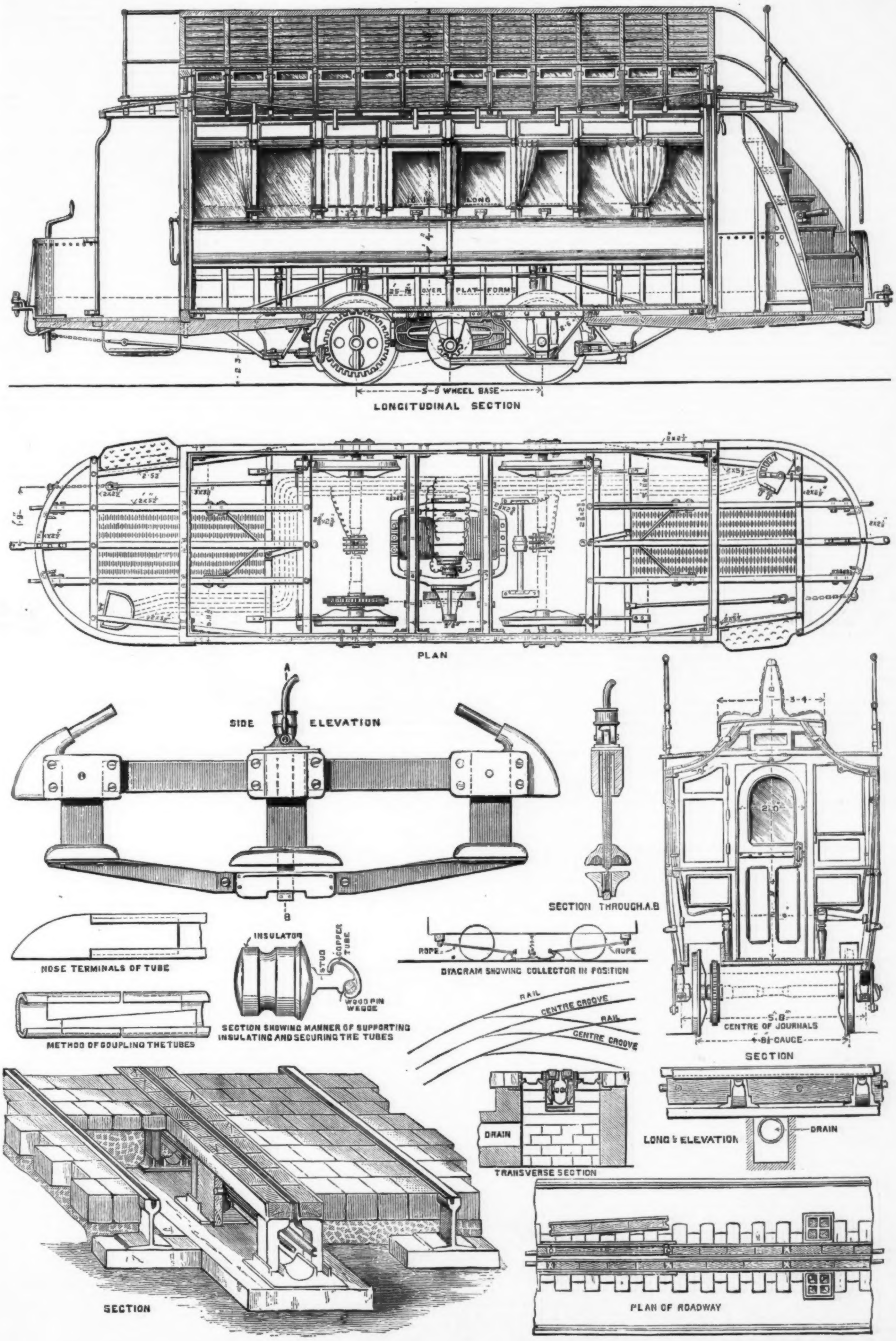


the former is keyed to the axle to which the second tram-wheel, T_1, is firmly attached.

The current passes from the underground central conductor by means of a collector, to be presently described, to the motor, and returns from the motor to an adjustable clip—Fig. 2—to the axle, and thus to the rails which form the return circuit. The single central conductor, which was open to the objection that pebbles or dirt falling through the slot would lodge on it, has been replaced by two half circular conductors placed to each side of the center line, and anything falling into the slot passes between the conductors to the bottom of the trough. We illustrate this

THE BLACKPOOL ELECTRIC TRAMWAY.

MR. HOLROYD SMITH, HALIFAX, ENGINEER



arrangement in Fig. 3, where L is the surface of the roadway, S S are the sleepers, and C C are cast iron chairs, which serve the double purpose of holding the angle irons, A A, which form the central slot in position, and of providing an attachment for the conductor, which consists of two half tubes of copper insulated from the chairs by the blocks, I I. To provide for expansion and contraction, the tubes are joined by special brass clamps, in which they can slide to a certain extent. The space, G, between the chairs can be flushed to remove obstructions which may have fallen into it, and sump holes—Fig. 4—connected with the main street drains are provided at intervals. Hand holes are also provided for facility in cleaning the channel and in fixing the sliding collector. The latter we illustrate in Fig. 5. It consists essentially of two pairs of fluted metal rollers, which by means of a knuckle joint and spring are pressed into the semicircular conductor. If any small obstruction were to occur in one of them, it is assumed that the fluted roller would begin to revolve, and thus clear the tube. In case of a large obstruction which would stop the collector, the leather belts, C C, would break, and the clip, J, by which the current is conveyed to the car, would become detached. The motive power being thus withdrawn, the car comes to rest, thus calling the attention of the driver to the obstruction in the channel, which can then be removed by hand. The collector is provided with steel plates, which pass through the central slot, but are insulated from the frame of the collector. The upper ends of these plates are held in two iron cheeks, which serve to carry one part of the insulated clip, J, the other part being attached to a cable suspended from the car. Connection between the clip and the collector is made by insulated copper strips placed between the steel plates, as shown. There are two leather straps, one for the forward and the other for the backward movement of the car. These straps are just strong enough to overcome a slight obstruction, but in case of a heavy obstruction they break before any damage is done to any other part of the apparatus. They can be quickly replaced.

All the essential details here described we find again in the Blackpool electric tramway, but considerably simplified. The differential gear on the driving axle has been abandoned, and both wheels are fast on the axle. On page 8432 we show a sectional elevation, a sectional plan, and also a cross section of the car. We also show a part section of the roadway in perspective, and various details relating to the conductor and collector. The conductor consists of two copper tubes of elliptical shape, and having a wide slot for facility of attachment to iron studs, which are supported in porcelain insulators. The latter themselves are attached to blocks of creosoted wood in the sides of the channel. The tubes are fixed to the studs by the simple device of a wooden pin wedge, and they are coupled to each other by two metallic wedges, as shown in our illustration. At each end of the case there is a switch box and resistance coils placed under the platforms, by which means the strength of the current and speed of car can be regulated. To reverse the direction in which the car is traveling, the direction of the current through the armature is reversed, the field magnets, which are shunt wound, remaining always magnetized in the same sense. With this arrangement there is no need to alter the position of the brushes, which in this case consist of two parallel sets of plates placed tangentially to the commutator, and pressed on it by spiral springs. There is only one handle to the two switch boxes, and that being in possession of the driver, the possibility of accidents caused by interference of others with the electrical connections is precluded. The current is generated by four-pole Elwell-Parker dynamos, which we have already described, and the motors are also manufactured by that firm.—*The Engineer.*

ELECTROLYTIC SEPARATION OF ZINC AND CADMIUM.

By S. ELIASBERG.

THE separation of these metals by gravimetric methods does not, as is well known, rank among the easier tasks of analytical chemistry. An electrolytic method was proposed in 1880 by A. Iver (*Bull. Soc. Chim. de Paris*), and requires consideration. He mixes the acetic or sulphuric solutions of the metals with 2 to 3 grammes sodium acetate, adds a few drops of acetic acid, applies heat, and electrolyzes by means of two Daniell elements. The author has examined this method at the request of Prof. Classen, and has found that the heat must be kept up during the entire duration of the electrolysis, as the cadmium is not completely deposited from a cold solution. The statement of the strength of the current as that of two Daniell elements is not sufficiently precise, as an equal number of elements of the same kind do not always give currents of the same strength according to the strength of the acids, etc.

It has frequently happened that two Bunsen elements gave off from 10 to 20 c. c. detonating gas per minute, according as they were more or less carefully prepared. This point requires particular prominence, since the author has not succeeded in getting good results with two Daniell elements which gave off 0·2 c. c. detonating gas per minute; the current was too feeble to throw down all the cadmium.

The strength of a current had to be ascertained at which all the cadmium was deposited, but not all the zinc. The most suitable current was found to be one giving off 0·5 to 0·6 c. c. detonating gas per minute. It was obtained by means of two Bunsen elements with the introduction of a resistance.

As to the concentration of the solution, nothing was laid down by Iver. According to the author's experience, the capsule must not contain more than 90 c. c. When this is the case, good results are generally obtained in six hours (not three to four, as stated by Iver). Sometimes, however, zinc oxide separates out in the capsule at the margin of the liquid, when the analysis is lost.

In the separation of these metals, the author uses soluble double oxalates. He proceeds as follows:

The metallic oxides are dissolved in hydrochloric acid, evaporated to dryness, mixed with 8 to 10 grammes potassium oxalate and 2 to 3 grammes ammonium oxalate, diluted to about 100 c. c., heated almost to a boil, and submitted to electrolysis, keeping up the temperature, but avoiding ebullition. The liquid does not evaporate away, as the steam for the most part condenses on the glass cover and drops back. If a considerable loss by evaporation is perceived, water may be added.

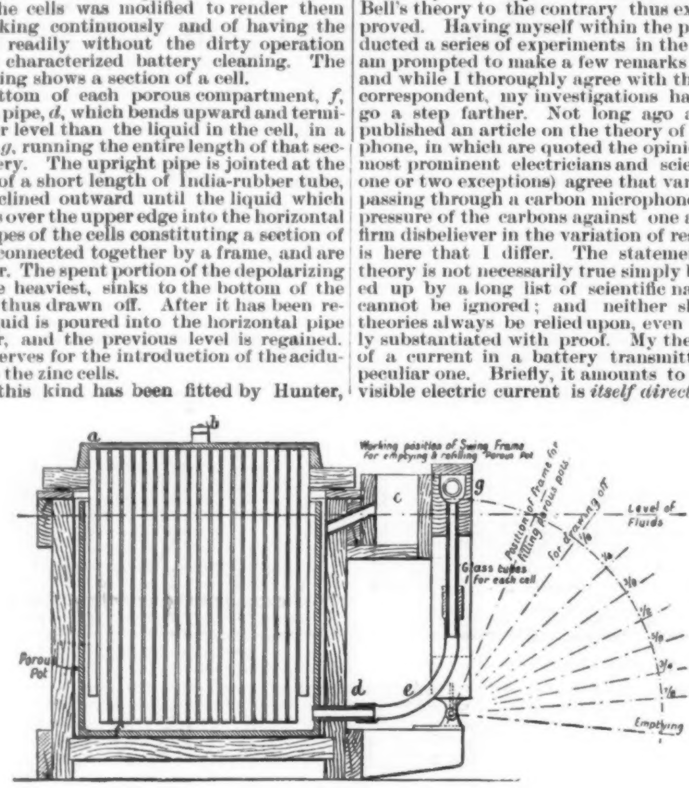
The strength of the current was 0·01 to 0·015 ampere, the evolution of detonating gas being 0·1 to 0·15 c. c. per minute. In six to seven hours the separation is complete. The cadmium separates out chiefly with a smooth surface, but partly in a crystalline form. If more than 0·15 gramme of metal are taken, a longer time is requisite.—*Zeitschrift fur Analytische Chemie.*

DOMESTIC ELECTRIC LIGHTING.

THE lighting of private houses by electricity is an attractive field to the inventor, and many attempts have been made, as our columns have shown, to devise apparatus by which the requisite current can be obtained by chemical means, without the employment of machinery. Among the batteries brought out for this purpose was one by Mr. O. C. D. Ross, which presented many features entitling it to a serious consideration. It was founded upon well-known and received principles, and while differing in the nature of its depolarizing fluid from previous batteries, its other elements—zinc, carbon, and acidulated water—required no test to prove their merits. The main point was that the arrangement of the cells was modified to render them capable of working continuously and of having the liquid renewed readily without the dirty operation which formerly characterized battery cleaning. The annexed engraving shows a section of a cell.

From the bottom of each porous compartment, *f*, there proceeds a pipe, *d*, which bends upward and terminates at a higher level than the liquid in the cell, in a horizontal pipe, *g*, running the entire length of that section of the battery. The upright pipe is jointed at the bend by means of a short length of India-rubber tube, *e*, and can be inclined outward until the liquid which stands in it flows over the upper edge into the horizontal pipe. All the pipes of the cells constituting a section of the battery are connected together by a frame, and are inclined together. The spent portion of the depolarizing liquid, being the heaviest, sinks to the bottom of the cell, and can be thus drawn off. After it has been removed, fresh liquid is poured into the horizontal pipe from a reservoir, and the previous level is regained. The trough, *c*, serves for the introduction of the acidulated water into the zinc cells.

A battery of this kind has been fitted by Hunter,



IMPROVED ELECTRIC LIGHT BATTERY.

Harrison & Co., London, at a mansion in South Kensington, and has been at work for more than six months with very satisfactory results. It has not been attempted to light the entire house, the field of operation being confined to the hall, the dining-room, the library, and the smoking-room. In these there are fixed twenty-three lamps of 10 candle-power each, mounted upon specially designed candelabra, which are prepared for the display of both gas and the electric light. The circuits are collected to a switchboard in the hall, where the lamps of all the rooms can be lighted, extinguished, and graduated by the insertion of resistances, at will. The current is supplied by four boxes of twelve cells each, grouped in compound parallel. Each cell is one square foot in cross section, and contains two zinc plates. It has an electromotive force of 1·89 volts and an internal resistance of 0·04 to 0·06 ohm. It is calculated that the entire cost of lighting, including interest and attendance, is ½ d. per lamp hour. This is very considerably more than the cost of gas, probably more than double, but in the class of installation we are considering, gas does not form the standard of comparison. There are in London hundreds of rooms in which no sane person would ever think of using gas. When the style of decoration goes beyond the conventional whitewashed or colored ceiling, some means of illumination must be found which does not require the renewal of the entire surface every two or three years. Hence lamps and candles still hold their own in the saloons of the rich, although even they are not free from the suspicion of throwing off a good deal of unconsumed carbon. The basis of comparison of cost, therefore, is not gas, but wax or oil, and in addition to the actual outlay there must be counted the time of servants employed in trimming wicks, the annoyance of an occasional ill-smelling flame, and the damage resulting from a dropping candle or an upset lamp. If all these be taken into account, the balance against electricity is very small, and would be outweighed by its great convenience. The initial expense of an installation, such as we have described, would not be great, the battery costing about 3*l.* per lamp. It must be remembered, however, that it may be made to serve far more than its nominal number of lamps, since all the rooms of a house are seldom in use at once. For instance, in the early part of the evening the inmates are gathered in the dining-room; later the drawing-room is occupied, and so on. In kitchens, passages, bed-rooms, smoking-rooms, and the like, gas serves very well at present and probably will continue to do so, but in reception-rooms containing gilding, painting, and delicate draperies there is a field for an electric light produced by chemical means; and if it can be shown that a battery will work satisfactorily through a London season in the charge of a man-servant, without overhauling, the expense of ½d. per lamp hour will not prevent its adoption.—*Engineering.*

CURIOUS TELEPHONIC EXPERIMENTS.

MR. WM. A. J. KOHRN, of San Francisco, writes to the New York *Electrician and Electrical Engineer* as follows: "In a communication recently published in the London *Electrical Review*, the writer describes a number of experiments in relation to microphonic transmission of sound. In circuit with a carbon microphone and telephone receiver he placed an automatic transmitter, in which he used a ribbon of paper having a line of small holes close together, running longitudinally through the center, similar to that used in the Wheatstone instrument. The 'automatic' was put in motion, allowing the current to pass through the microphone. The continuity of the circuit was continually broken, and words spoken directly to the carbon microphone without the intermedium of a diaphragm, and without any substance whatever below the carbons, were distinctly heard from the receiver, the articulation being as perfect as when the current was continuous. The writer has come to the conclusion that an undulatory current in a closed circuit is not necessary for telephonic transmission, and considers Bell's theory to the contrary thus experimentally disproved. Having myself within the past two years conducted a series of experiments in the same direction, I am prompted to make a few remarks upon this subject; and while I thoroughly agree with the aforementioned correspondent, my investigations have enabled me to go a step farther. Not long ago a scientific paper published an article on the theory of the carbon microphone, in which are quoted the opinions of some of our most prominent electricians and scientists. All (with one or two exceptions) agree that variations of current passing through a carbon microphone are produced by pressure of the carbons against one another. Being a firm disbeliever in the variation of resistance theory, it is here that I differ. The statement that a certain theory is not necessarily true simply because it is backed up by a long list of scientific names is one that cannot be ignored; and neither should 'accepted' theories always be relied upon, even though seemingly substantiated with proof. My theory of the action of a current in a battery transmitter is certainly a peculiar one. Briefly, it amounts to this: that the invisible electric current is *itself directly influenced* by the impacts of air affected by the voice, and that the microphonic contacts have *nothing whatever* to do with the transmission of speech in the sense of producing electrical undulations by variation of resistance in the circuit. In order to substantiate this theory, one of my first experiments consisted in affecting the current in a sufficient degree to deflect the needle of an ordinary detecter galvanometer by producing sound upon a microphone (?) transmitter; the carbon 'contacts,' instead of being in direct electrical connection with each other, were, *fully one-eighth of an inch apart.* This may appear incredible, but it is nevertheless true. Not only have I succeeded in producing a telephonic receiver without the use of either magnets, diaphragms, wire, or resonating cases of any sort, but also in transmitting articulate speech to considerable distances with a break in the conducting wire. At the conclusion of my investigations, I hope to present to your readers a full account of these experiments in detail, and elucidate my theory in regard to the electrical transmission of sound."

AN ELECTRIC SUPPER.

THE residence of Mr. Wm. J. Hammer, No. 23 Rowland Street, was the scene of an entertainment on New Year's Eve which, for the display of the powers of electricity, has seldom been equaled. The High School Class Society of 'Seventy-seven, which took possession of the premises at the invitation of Mr. Hammer, and of which he is a member, were not prepared for the new tricks which had been arranged, and evidently expected that some of the old ones would be repeated. Not so, however. Mr. Hammer's acquaintance with the "Boys of '77" has taught him better, and he succeeded in getting a number of victims. The wide awake "S. S. S." stepped on the stoop, rang the bell, and lighted three electric lamps by so doing; and when he entered the door and divested himself of his coat and hat, he was invited to touch a little button and have his boots shined by electricity. He was soon forced to let go the button and remove his understandings. He was then invited to take a seat, and as he did so a dunce's cap dropped on his head, and this harmless act was the means of putting life into four gongs, a triangle, a tambourine, and drum. The silver lemonade pitcher was so charged with electricity as to render it unsafe to pour out a drink. The musician of the class was invited to seat himself at the piano and start up some of the old tunes which the "powers that be" at the High School used to persuade the scholars to sing every morning; but when he had played one of the verses about half way through, there emanated from that bewitched instrument a conglomeration of sounds that

drowned the voices of the singers and startled the neighborhood. The visitors were then treated to a display of electric experiments, and revolving Geissler tubes illuminated the rooms with beautiful colors. The display was under the direction of Mr. Hammer and Prof. Geo. C. Sonn. The members of the class with invited guests, among whom were Walter H. McDougall, the artist, and Mr. Donika, of the editorial staff of the *World*, were then escorted to another room, where an electric supper had been prepared, presided over by Jupiter, who in full dress suit sat at the head of the table and shouted by means of a small phonograph inside of his anatomy, "Welcome Society of 'Seventy-seven and their friends to Jove's festive board." The menu was as follows: "Electric Toast," "Wizard Pie," "Sheol Pudding," "Telegraph Cake," "Thunderbolt Pudding," "Magnetic Cake," "Menlo Park Fruit," "Incandescent Lemonade," "Electric Coffee," "Electric Cigars," and music by Professor Mephistopheles' Electric Orchestra. Promptly at 12 o'clock, and as the year 1885 faded away, the thunderbolt pudding exploded, the sheol pudding blazed forth red and green fire, illuminating the room, the telegraph cake clicked messages, bells rang inside the pastry, incandescent lamps burned under the lemonade, while the coffee and toast made by electricity were rapidly "absorbed." The magnetic cake disappeared, the wizard pie vanished, Jupiter raised a glass labeled "Jersey Lightning" to his lips and began to imbibe.

The effect was astonishing. His eyes turned green, his nose assumed the color of a genuine toper, the electric diamonds in his shirt bosom blazed forth in all their glory, and he shouted phonographically "Happy New Year! Happy New Year!" When the wires were removed from his head and hands, he became more gentle. The lights were then extinguished, and Mr. Hammer gave an illustration of the Bartholdi statue when completed. In the center of the table was placed a miniature statue, and in its head there was placed an incandescent lamp, about as large as an ordinary sized bean, and this small lamp was of sufficient power to light a good-sized room. At the conclusion of the supper speeches were delivered by Messrs. Hammer, Rutan, McDougall, Motham, Dent, Sonn, Brown, Delano, Worl, Donika, and Dawson, and a poem read by Mr. Van Wyck, which appears on another page, and may prove interesting to old High School pupils.

The last but not less interesting display of electricity took place in front of the house, when rockets and Roman candles were sent up by electricity. At an early hour of the morning the visitors departed, wishing Mr. Hammer a happy new year and voting the entire affair a success. Among the curiosities displayed was a collection of incandescent lamps, said to be the largest in the world, and numbering between two and three hundred, gathered from all over Europe and this country.

Little Miss May Hammer was dressed as the Goddess of Electricity, with tiny Edison lamps in her hair, as earrings, breast pin, and held a wand surmounted by a star containing a tiny lamp.—*Newark (N. J.) Advertiser.*

SOURCES OF SALTPETER.

By C. G. WARNFORD LOCK.

WHILE every miner is attracted by mineral veins which promise to yield metals, the majority overlook a class of earthy products which, nevertheless, possess considerable commercial value. Foremost among these is saltpeter, or potassium nitrate. The following notes on this useful salt have been collected by the writer at various times and in various localities, and will probably be interesting to many readers of the *Journal*, as accessible information on the subject is not abundant, and some of the deposits alluded to seem worthy of better development.

The generally accepted conditions necessary for the formation of saltpeter are (1) the presence of decaying organic matter, whose decomposition affords a supply of nitrogen; (2) access of atmospheric air to oxidize the nitrogen into nitric acid; (3) sufficient potash in an available form (such as wood ashes or decomposed feldspathic rocks) for the nitric acid to combine with as fast as it is liberated. Given these conditions, the formation of the salt will take place in very varied situations, being most commonly observed in countries where a tropical climate favors the decomposition of organic matters. With this introduction, we may proceed to indicate the chief localities of production.

France.—Though commercially insignificant, it is worth noting that a considerable accumulation of saltpeter takes place in a series of caves near Roche-Guyon, and Mousseau, on the banks of the Seine, which are utilized as stables; the nitrous earth yields on analysis from 3 to 5½ per cent. potassium nitrate.

Spain.—The soil in some parts of Arragon, Catalonia, and New Castile bears a nitrous efflorescence, which is worked at Alcazar de San Juan, Zaragosa, and Tremblaque.

Italy.—Saltpeter caves occur at Pulo di Mofetta, on the Adriatic.

Hungary.—Great numbers of niter pits are met with around Semeny, Debreczin, and Nagy Kallo (Kanizsa).

Cape Verde Islands.—Much has been said about the existence of saltpeter in the Sotavento or "Leeward" portion of this archipelago, and it has been reported of the two Rombos, Brava and Fogo, that their deposits were the subject of rational working. The chief supply, in Brava, was reported at the Porto do Anciao, a little bay on the southwest. The veins here were said to occupy several horizons, and to vary in thickness from a knife-edge to two inches. From these veins the natives dislodged the mineral by means of bricklayers' hammers and small axes. Recent inquiries tend to throw discredit on these circumstantial statements, which may have been founded only on the evidence of the Portuguese traveler Valdez, who described the islands without troubling to pay them a visit. Now it appears that Fogo alone affords a small quantity of saltpeter, gathered in a precarious manner by the residents.

Turkey.—In Macedonia, saltpeter is collected in the neighborhood of Uskiub and Kiuprili, in the Vardar valley, and transported thence to Constantinople.

Asia Minor contains very extensive saltpeter deposits, which have not received the attention they deserve. These may be said to lie between 30° and 36° E. longitude from Greenwich, and between 37° and 39° N. latitude. In this region there is a vast expanse of saline marsh, whence culinary salt and saltpeter are got by the people of the district. In the neighboring hills of red sandstone, salt is dug out of horizontal beds. The Lake Buldur presents the curious phenomenon of affording quite fresh water at the surface, while beneath it is distinctly nitrous. At the village of Karabounar, the entire soil is strongly impregnated with saltpeter, and it even forms an efflorescence on the surface, after rain has fallen. Obviously, volcanic action has played an important part in the formation of these deposits, just as it has done in the sodium nitrate beds of Peru; for everywhere the soil is more productive of the mineral as the volcanic strata are approached. The soil is removed and washed with hot water; the solution is then evaporated in wooden troughs. The industry at this spot is, or was, a government monopoly; the whole yield, some 20,000 to 25,000 okes (say 20 to 25 tons), being sent to the powder factory at Constantinople. The price there paid for it is 56 paras per oke (say £14 10s. 2d. per ton), of which sum 16 paras (£4 2s. 10d.) per ton are allowed for carriage, and 40 paras (£10 7s. 4d.) per ton for cost of preparation.

At Ak Serai the marshy plain is covered with a yellow efflorescence, mainly consisting of saltpeter, which is collected in large quantities. In fact, saltpeter forms, with madder, the chief commercial staple of the district, and the decline of the madder culture brought about by the development of the coal-tar dye industry leaves the saline product the principal source of profit to the inhabitants. The degree to which the soil is impregnated in this neighborhood is evidenced by the fact that, after rain has fallen, effloresced saltpeter is scraped in large amounts from the very walls of the houses. But being here likewise a government monopoly, the residents are not permitted to gather it from their dwellings on their own account, but are paid a small sum for their trouble by the contractor who farms the monopoly. At a distance of about five miles from Ak Serai, in a N.N.W. direction, the soft, muddy ground is permeated with saline matters, which feature extends far to the S. and S.E., the river Bens Su losing itself in the soil before reaching the great salt lake of Touz Ghieul.

The plain lying to N.E. of Injesu and Mount Argæus (Erjish Dagh) is, in some places, covered with a thin saline incrustation, which would probably yield more or less saltpeter by lixiviation. Near the western gate of the town of Cæsarea again there are some extensive saltpeter works, where the mineral is gathered in large quantities from the soil. Kiz Hissar also contains numerous saltpeter works; the article is collected in abundance from the soil in and around the place, as much as 40,000 okes (say 40 tons) being sometimes prepared in one season. Mention may here be made of Lake Asmabous, lying in the midst of a perfectly level plain; it measures about 40 ft. in diameter, and is full of brackish, turbid water, bubbling and "boiling" all over the surface, but especially in the center, the commotion being evidently caused by an escape of vapor, and suggesting the propriety of testing for the presence of boracic acid, which occurs in a parallel manner in the Tuscan lagoons.

The extensive plain of Bor, or Nigdeh, which is flooded in winter, is, in dry weather, covered with a saline efflorescence in patches, the character of which is testified by the presence of some remains of dilapidated niter works. In many of the localities above alluded to, there are also indications of boracite and pandermite, awaiting further research.

India.—Some saltpeter is obtained from the slimy mud deposited by the River Ganges during the flood season. Analysis of a nitrous earth from Tirhût, in Bengal, gave 8·3 per cent. of potassium nitrate and 3·7 of calcium nitrate, or 12 per cent. of total nitrates. The soil around old buildings in the Punjaub is very productive of niter, which appears as an efflorescence, not to be confounded with the sodium sulphate crust occurring on the *reh*, or barren lands. The deposit is scraped up as often as it is renewed, and submitted to simple treatment for the separation of the niter from the accompanying dirt by the agency of water and filtration. A small spade is used in collecting the earth, which is taken off to a depth of one to two inches, and piled in heaps two to four feet high, where it is left without taking harm till an opportunity arises for transporting it to a spot where water and fuel are available.

In the upper part of the Punjaub, the extraction process is conducted in a series of wide-mouthed earthen pots, with an aperture in the base, supported on earthenware stands, so as to admit of placing cups beneath the pots. On the bottom of each pot is spread a bed of straw, covered with a layer of wood ashes; above this, the nitrous earth is added till it reaches nearly to the top of the pot. Then water is applied till all soluble salts contained in the earth have been dissolved and carried in solution into the cups below. The straw bed acts mechanically as a filter to hold back insoluble matters; the wood ashes act chemically, affording potash in an available form, so that any calcium nitrate present may be converted into potassium nitrate, the nitric acid in the calcium nitrate exchanging bases with the carbonic acid united to the potash in the wood ashes. The very weak nitrous solution thus obtained is used instead of fresh water for washing through the contents of another series of pots, and thus becomes gradually charged with saltpeter to the extent of 2 or 3 per cent.

The next process is the removal of the water and crystallization of the salt. This is conducted in elliptical iron dishes, measuring one or two feet across and six to nine inches deep, heated from beneath; as evaporation proceeds, fresh liquor is added, during a period of twelve to eighteen hours. The scum which rises is skimmed off, and at a certain point of concentration the crude potassium nitrate, with accompanying saline impurities, is abundantly precipitated. This product in some districts is termed *dhouah*, and contains 45 to 70 per cent. of potassium nitrate. The small pans used in the upper Punjaub give 8 to 16 lb. of crude niter per shift of 30 to 36 hours. Over 4,000 pans are kept working in the Punjaub, paying an annual tax of two rupees. In addition, there are over a dozen large shallow basins called *agar*, where sun-heat is utilized for evaporation. These pay eight rupees yearly.

In the different districts, slight modifications of the process described above are in vogue. Thus, in Mooltan, the liquor, after twenty to twenty-four hours' boiling, is often run into a vat to cool for a night, and next morning the crystals are raked out and washed in a woolen cloth, being then tied up in it, and exposed to the sun till the moisture has been dissipated. Sometimes the filter is made on the ground in an inclined situation, being formed with mud walls lined with stiff clay on three sides, the remaining side being left open for escape of the liquid, but provided with reeds or closely woven grass mats, with or without a bamboo false bottom; the liquid passes into a reservoir made of pucka masonry. In Guzerat, the nitrous solution is passed through a cloth filter; it is evaporated to about one-fourth its bulk, and on cooling affords an impure crystalline product (*dhouah*), worth about three rupees per maund (say 8s. per cwt.). When redissolved, filtered, and recrystallized, forming *kalmee*, it is worth eight rupees per maund. The following table of the average cost per ton of Indian saltpeter is instructive:

	£	s.	d.
Prime cost of crude material at the factory	4	2	0
Salaries, bags, packing, etc.	1	14	2
Freights and expenses from factory to Bombay	5	17	3
Interest on outlay at 9 per cent		13	8
Government license		2	7
Insurance at 7 per cent		17	1
	13	6	9
Profit per ton	1	0	3
Selling price at a brisk demand at Bombay	£14	7	0

Indian exports of saltpeter reach something like 25,000 tons annually, with a value of over half a million sterling.

Ceylon.—The nitrates of potash and lime are of frequent occurrence in Ceylon. Some thirty places might be enumerated where saltpeter is produced and has been prepared for market. The formation of the mineral is apparently confined to caves in dolomitic rocks, the feldspar in which contributes the potash base. The caves are generally remote from inhabited places, being situated in desolate and not easily accessible regions. Future explorations in the interior will probably add to the number already known. While some of the caves are the resort of vast numbers of bats, whose dung accumulates in them, others are quite untenanted.

An analysis of the most productive niter rock near Doombera, in an unfrequented cave, showed 2·4 per cent. potassium nitrate and 0·7 per cent. of magnesium nitrate. The niter earth from the great cave in Lower Ouva, near Wellaway, yields 3·5 per cent. of calcium nitrate and 3·3 of potassium nitrate. The niter crop is harvested during six months of the year by chipping off the incrusted portions of the walls of the caverns; the fragments are reduced to powder, mixed with an equal portion of wood ashes, and dosed with water. The potassium nitrate present, as well as that produced from other nitrates by the action of the wood ashes, is dissolved by the water, and the solution is evaporated, first in pits exposed to the sun's rays, and then to the crystallizing point in fire-heated pans.

Burmah.—Some of the caves contain accumulations of nitrous earth, and the preparation of the salt is carried on extensively between Pugan and Ava, on the Irawadi.

Thibet.—In the government of Rudokh, saltpeter is obtained by digging up the soil, which is put into brass vessels, and treated with hot water. The solution thus formed is decanted into another vessel and there allowed to cool, that the niter may crystallize out. By the crude native method, one man can prepare a sheep load (say 20 lb.) in three weeks.

Turkestan.—Within the limits of the Khanate of Chiwa, on the left bank of the Amu-Daria, in a southwesterly direction from Fort Nukus, lies a district some two miles square in area, covered with a layer of nitrous earth, exhibiting the following composition:

Matters soluble in water	27·89
" insoluble in water	72·11

The soluble portion consists of:

	Per cent.
Potassium nitrate	5·52
Sodium nitrate	4·05
Magnesium nitrate	1·04
(Total nitrates)	(10·61)
Sodium chloride	12·90
Calcium sulphate	3·25
Magnesium sulphate	0·66

Saltpeter abounds in Eastern Turkestan, especially in the hills beyond Karshi (Moore's Neksheb), a large town ninety-one miles southeast of Bokhara. Here, previous to 1875, the Emir had a large powder factory, the powder of which was sold in Bokhara for fifteen kopecks (five pence) per one and one-quarter pounds. Other factories existed in Khokan. According to some authorities, however, the best saltpeter is procured from Guzar, in Northern Afghanistan, which is said to rival the Persian volcano Demavend itself in this respect.

Sumatra.—The niter caves in the county of Caltown, near the land of the Duni River, are filled with nests of innumerable birds of the swallow kind, which abound the more the further the caves are penetrated. It is their dung, forming a deposit in many places four to fifteen feet thick, which forms the saltpeter. A cubic foot of this earth, on boiling, will afford something like eight pounds of niter.

Brazil.—In the Rio das Velhas, on the right bank of Ypoeira, saltpeter is found in quantities at the southeastern side of the Serrote, in a series of caves. The process of extracting the niter from the chocolate-colored earth is one of lixiviation. The earth is put into a bangue or strainer, generally consisting of a square pyramid of boarding, with the base upward. The poorer people use a hide, supported on four uprights. When exhausted with hot water, the nitrous particles find their way, duly filtered, through a tube leading to a *coche*, or trough, often a bit of old canoe. The *decoada*, as it is now called, is a thin, greenish liquid, which must be boiled in a *tacho*, or metal pan, like that used for sugar. This *tacho* is sometimes mounted upon an ant-hill. The niter is purified by repeating the process, and assumes a yellowish-white color. It has been used for making contraband gunpowder.—*Journal Society of Arts.*

FIRE-PROOF INDIVIDUALS.

BURNING is undoubtedly that kind of pain against which the organism most strongly revolts. The fear of being burned is extreme in both man and the lower animals; and it may be said that it exists in the animal kingdom as a powerful instinct. Fire is feared by wild animals; and domestic ones, such as the dog and cat, while they love heat, become greatly frightened, and escape, when a firebrand or a spark falls near them. This fear, this horror of being burned, which is so powerful in men, accounts for the fact that from all times the wonder and curiosity of the public have been excited by those who are capable of handling burning coals or red hot iron with impunity, or of touching molten cast iron and lead, and by those who are proof against flames and boiling water or oil.

Molten metals.—Dipping the hand into molten metal is an experiment that has been known from remote antiquity. History relates that Zoroaster, desiring to confuse his calumniators, allowed molten brass to be poured upon his body, and received no harm. A large number of authors of the middle ages, especially Ambrose Pare and Cardan, tell us that they have seen charlatans dip their hands into molten lead and wash their faces with it. In our day, numbers of charlatans perform like experiments. In lead works a workman will unhesitatingly put his hand into a bowl of melted lead, in order to take out a coin that a visitor has thrown into it; and in foundries workmen are often seen dividing with their hands a jet of melted lead or steel issuing from a crucible (Fig. 1).

Mr. Boutigny, who has studied this question, and whose theory will be given further along, has repeated these experiments, and here is what he says about them: "Cowley having taken the initiative, we cut the jet of molten iron with our fingers. We plunged our hands into the moulds and into the crucibles filled with iron that had just been poured by one Wilkinson, and the radiation from which was insupportable, even at a great distance. We varied the experiments for more than two hours. Mrs. Cowley, who was present, allowed her eight or ten year old daughter to put her hand into a crucible full of incandescent iron; and the thing was done with impunity."

The explanation of the organism's resistance to the contact of metals in fusion whose temperature is very high, such as iron and copper, lies, according to Mr. Boutigny, in the spheroidal state into which the slight moisture of the experimenter's skin resolves itself. Without entering into details that may be found in works on physics, let us recall the fact that a drop of water, falling upon a strongly heated plate of metal, instead of at once vaporizing, takes on the form of a little sphere and remains in this state until, the plate being cool enough, it abruptly evaporates. Now, according to Mr. Boutigny, the multitude of droplets of water that occupy the pores of the skin, coming suddenly into contact with a body whose temperature is exceedingly high, as molten iron for example, assume the spheroidal state, interpose themselves between the iron and the surface of the skin, and form a genuine protecting glove for it.

Persons proof against red hot iron and flames.—In antiquity, examples of fire-proof individuals were very numerous, and the Greek and Roman writers who tell us of the extraordinary power of these persons attribute it in most cases to divine intervention, but in some to a purely physical preparation. The following are a few of the examples cited. The priestesses of Diana Parasya at Castabala, in Cappadocia, attracted the veneration of the faithful by walking barefooted upon burning coals, according to Strabo. The same author tells us that the most fervent adorers of the goddess Feronia acquired the power of walking with impunity upon live coals. Those whom the goddess deigns to inspire with her breath, says he, walk without harm upon brasiers and heaps of red hot cinders, and this prodigy is renewed every year at the goddess's festival. The Hirpi, during the annual festival held upon Mt. Socrates in Etruria, performed the same miracle.

Their pretended hereditary incombustibility gained for them exemption from military duty, and several other privileges accorded by the Roman Senate. But Varro says their incombustibility was due merely to a coating which they spread upon the soles of their feet, and of which they held the secret. This theory of a fireproofing material is also found in an old Oriental tale, the hero of which traverses some water that is boiling without the aid of fire, and walks over red hot steel plates, thanks to a pomade with which he had rubbed his body.

Judicial trials by fire show that numbers of persons were either able to render themselves, or be rendered, fire-proof. In Hindostan, the antiquity of this sort of trial dates back to the gods. Sitah, wife of Ram, in order to clear herself from injurious suspicion, walked barefooted upon a glowing fire. As Sitah's foot, say the Hindoo historians, was enveloped in innocence, the devouring heat was for her as a bed of roses.

A few years ago a traveler related having seen in India two accused persons submitted to judicial trial by fire, and one of them carried a red hot iron ball without being burned thereby. The other was terribly burned by boiling oil, and was declared guilty. His accuser was a Brahmin.

Trial by fire was likewise in vogue in Greece. "We are ready to handle fire and walk through flames in order to prove our innocence," cry the accused Thebans in the Antigone of Sophocles. In the middle ages we find it employed still more than ever. Pachymera, toward the 13th century, says that he has seen several accused persons prove their innocence by handling red hot iron. At Didymotheca, toward A. D 1340, a woman accused by her husband had to undergo the red hot iron test. Although she had confessed her crime to the bishop of the city, he nevertheless got her to submit herself to the trial. On the day of the latter she took the red hot iron in her hands on her husband's orders, walked around a chair three times, and then laid the iron upon the latter, when the straw seat of the same immediately burst into flames.

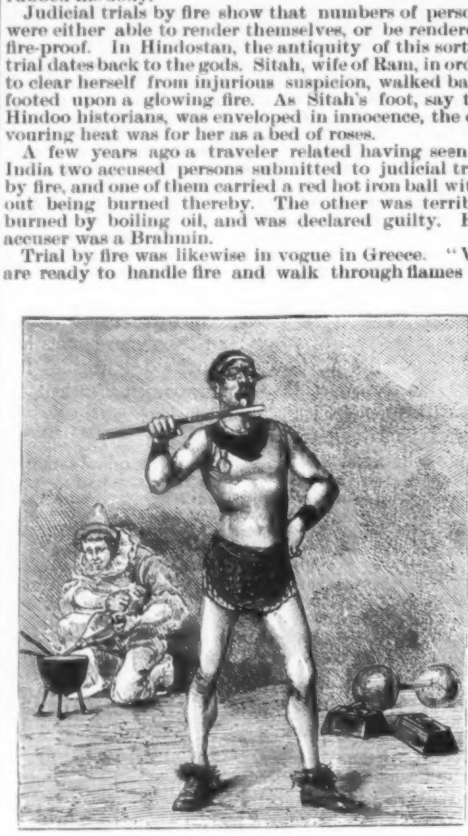


FIG. 2.—A MOUNTEBANK LICKING A RED HOT BAR OF IRON.

At the beginning of the eleventh century, Deacon Poppon, in order to bring Sueno II., King of Denmark, and his subjects back to Christianity, put his naked hand and arm into a white hot iron gauntlet and went amid the terrified Danes to deposit it at the feet of the prince. When he took his hand out of the gauntlet, it was unharmed.

Another excellent example, dating back to the same epoch, is the following: Harold, son of Magnus, King of Norway, proved his right to the throne by walking bare-footed with impunity upon red hot iron.

We find this same proof against fire among savage peoples. In Africa, for example, Portuguese travelers have seen Caffirs clear themselves of an accusation by handling red hot iron. Among the Yoloffs, according to the traveler Mollien, if a man denies the crime of which he is accused, a very hot iron is applied to his tongue. If he is innocent, the iron does not burn him, and this very often happens. Exhibitions of Arabs walking upon white hot iron plates have several times been witnessed at Paris.

The fire test of the middle ages was especially reserved for persons who, by reason of old age, an infirm state, or their profession, could not clear themselves of accusations brought against them by fighting their accusers in camp by judicial duel. It had a religious character, and was performed in a church under direction of the clergy. The fires were consecrated. The priests directed all the preparations, the accused remaining under their guard the three days preceding and the three succeeding the trial. To prevent the accused from preparing his hands, the latter were covered and put under seal for these six days. It is allowable to judge from these facts that the accused whose innocence was to be proclaimed had his hands submitted during this period to a preparation that rendered them proof against fire. Those on the contrary who were to be declared guilty were not allowed to take measures to preserve themselves against burning.

It was not till the end of the seventeenth century (about 1677) that the question of the proof of man against fire was looked at from a scientific standpoint, and this by the physician Dodart, a member of the Academy of Sciences. The study was suggested by the wonderful experiments that were being performed at the time at Paris by an English chemist named Richardson, who walked barefooted upon live coals with impunity, who melted brimstone and placed it all afire upon his hand and then upon his tongue, and who placed live coals upon his tongue and cooked a piece of meat upon them, the action of the fire being kept up by means of a bellows in the hands of a spectator. He held a piece of red hot iron in his hand without the least trace of a burn being left, took a bar of red hot iron between his teeth and threw it to a distance, and also licked the same with his tongue as is sometimes done in our own day by mountebanks at fairs (Fig. 2). He likewise swallowed molten substances. In all these experiments his face was placid, and showed not the least sign of pain.

Dodart explained that these experiments could be performed without the aid of any chemical preparation, simply by taking a few precautions, and also as a consequence of the hardening that the epidermis may acquire under the influence of an oft-repeated action.

In another article we shall examine the completest explanations that can be given of these curious facts. —*La Nature.*

FIG. 1.—A WORKMAN PASSING HIS HAND THROUGH MOLTEN IRON.

ECONOMIC POSITION OF AUSTRALIA.

THE following is taken from the London *News* of recent date:

The aggregate population of Australasia is now nearly a tenth of that of the mother country. The revenue increased last year by £922,000, the total being £22,298,000, or about a quarter of that of the mother country; but of this only £8,467,000 was derived from taxation, being about the same per head as in this country. The public debt of the Australian colonies increased last year at the rate of more than 10 per cent., and has continued to grow quite as rapidly this year. Most of this debt being for railways, which pay their way, the net debt of Australia is in reality very small. Every new mile of railway opens up about 1,000 acres of land for cultivation, at least that was the proportion of new land under cultivation last year to the new railway mileage, and previously the ratio was far greater.

Australia is most excellent as a pastoral country; its production of wheat last year was about half as much as in the United Kingdom, and was therefore in excess of the needs of the people; but the supplies of sheep and cattle are so immensely above the possible local requirement as to make Australia virtually a great grazing farm, supplying pastoral produce to the more crowded countries. Happily for those concerned, no large sums have been borrowed and spent in the machinery, barns, fences, and so on, which are so depreciated in old agricultural countries. Australia started by being pastoral, and has remained so. It is difficult to imagine any occupation less dependent upon the modern systems of capital and division of labor. No country could have had a fairer start in material progress than Australia, because the preliminary outlay was small. The world needs meat and wool even more than it needs gold, and those who first went to dig yellow wealth have remained to raise animal produce, more profitable still. Drouth last year reduced the number of sheep to 74,346,000, being nearly three times as many as in the United Kingdom; of cattle to 8,179,000, compared with 10,000,000 head in this country.

Australasia must be subject to changes like other countries; but, unlike other countries which depend upon the produce of the soil, the variations of material prosperity in Australia are marked by extremely swift progress at one time, followed by stationariness rather than retrogression at another time. There was a drouth last year, which cost these colonies 15,000,000 sheep; which brought losses upon the squatters, who were compelled to realize for want of feed; which depressed the business of up-country stores; which did not fail to affect the profits of banks among other trading concerns, and which spread a feeling of depression throughout Australia. There was, however, no sign of widespread disaster. Several Australian joint stock companies reported a shrinkage of prices; but punctual payments of farm rents nevertheless are also reported. Here and there a reduction of reserve fund or capital account had to be faced by shareholders; but, on the whole, a bad time had been passed through without much trouble, and it was rather an unprogressive time than a period of absolute depression. The low prices of metals and wool have continued to check the material progress of Australia; but the drouth having ceased, the reports which reach this country have again assumed a cheerful hue. . . .

What Australia has now to contend against is the low price of wheat, wool, and metals; the wool question far exceeding in importance that of any other article. Of wool alone we import three times as much from Australia as the other articles put together, and the price of wool is now only half what it was in 1880; for instance, the price of Port Phillip unwashed is quoted 7½d. per pound, in contrast with 10d. a year ago, and 1s. 2½d. in 1880. Every decline of 1d. per pound in the price of wool makes a difference of £1,500,000 to the revenues of the people of Australia.

But while it is likely that the selling price of wool will never be again so profitable as in past times to Australian growers—for cheap cotton and silk affect the wool market as well as the increased production of wool itself—the advantages with which Australia started must continue to weigh. The great future rival of Australia is not our home grassland, nor the soil of North America—it is South America. In the Argentine Republic there are already as many sheep as in Australia. The last estimate for the Plate district was 90,000,000 sheep, 16,000,000 cattle, and 4,800,000 horses; but here comes in the contrast between well-managed and ill-managed borrowings. Australian governments have never been subjected to wars and revolutions like the Argentine States; the people, being almost all Anglo-Saxon, have not been hurried into excesses by the boiling blood of a majority of Spanish and Italian immigrants. This republic has the benefit of a splendid climate, unlimited area, and to some extent also of railway communication. But in the last respect it is far behind the Australian colonies, whose 8,000 miles of railway are three times the corresponding mileage in the Argentine Republic. It is difficult, however, not to believe in the future of pastoral countries, whether situated in Australia or South America. If the Plate can raise capital to extend its railways indefinitely, it will be indefinitely a rival to Australia; but in the matter of credit the Australian colonies are far ahead—they have better security for property, less taxation, and a steadier population. In a fair field the Australians will always be able to export wool, meat, hides, etc., more cheaply than the Argentine Republic; and when capital is required for the extension of the frozen-meat trade, as it will infallibly be requred, Australia will still be in front.

THE FROEBEL METHOD.

Among the objects used for teaching young children there are few as ingenious and as useful as those that pertain to the Froebel method, which is one that is well known in foreign countries and well worthy of being recommended among us. This method consists in giving children's playthings a form capable of instructing. The balls adopted are variously colored blue, white, red, etc., and this gives the child an idea of color. Other playthings consist of cubes, cylinders, and spheres of cardboard, with which the child amuses himself just as well as he would with common ninepins, but which allow him to unconsciously acquire a notion of geometrical solids.

Numerous games of skill form part of the Froebel method. At present we make known to our readers a new example of useful work, forming a portion of the extensive series of small devices pertaining to this mode of teaching. Froebel has given the name of hammer and anvil to the tools used, and which are contained in a cardboard box. In this latter the child finds patterns made of very thick paper, which he is to cut out. Fig. 1, for example, at Nos. 1 and 2, represents the two sides of a rocking chair. After these have been cut out, each side of the paper is punctured at certain points indicated by lines. The apertures are made by means of a punch, wooden anvil and mallet, that are found in the box. A series of whitewood rods (T T', Fig. 1) is also contained in the box, and it is only necessary to insert these in the apertures to form the rocking chair shown at No. 3.

Fig. 2 represents a series of small objects that the child may manufacture with his tools out of cardboard. Here we have an egg-holder, baskets, a sled, box, eating trough, bench, ladder, etc. The tools necessary for these small, ingenious, and recreative operations may be easily prepared by any one at slight expense. The small wooden rods are cut to the desired length for each object. Such an occupation is for the child a subject of reflection that develops his aptitude for reasoning, while at the same time exercising his manual skill.—*La Nature.*

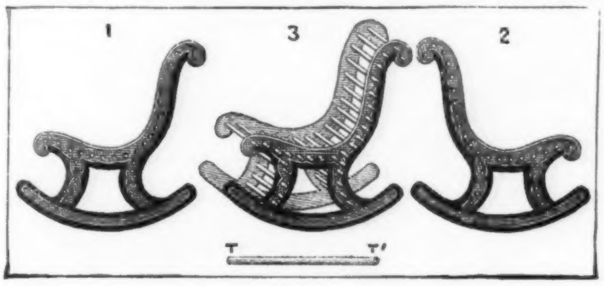


Fig. 1.

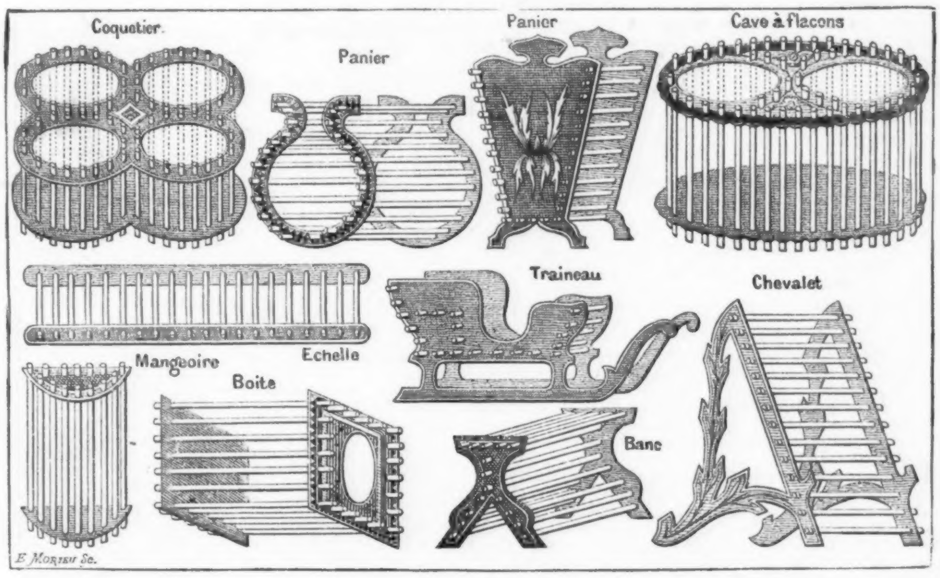


Fig. 2.

CARDBOARD OBJECTS PERTAINING TO THE KINDERGARTEN METHOD OF INSTRUCTION.

QUARTZ AND ITS VARIETIES.

By W. S. Beekman.

Among the various studies of natural history, mineralogy is said to be the most refreshing to a tired student, the wonder of the uninitiated, a continual source of enigmas to the collector, and a thing of beauty to every one, be they intelligent upon the subject or deficient on the laws that make some quart(s) smaller than others.

The wonders of nature are endless, and the animated world offers wonders that occur in objects invisible to us more miraculous than what we find in the inorganic kingdom. Yet, what is there neater, or that requires less care to protect from atmospheric changes, than minerals, while in our cabinets? All other forms of collecting are valuable in their way, but for a young collector they require a larger capital at the outset than the majority can invest.

A cabinet of minerals can be formed from the stone walls around one's house, and it will present enough material for genuine study to satisfy any Yankee's inquisitiveness. More attention should be paid to local rocks than is; simply because one has seen a variety from some other place that excels the ones he has in quality is no sign that he should throw away the coarser specimens as valueless. That is natural, but at the same time it is well for collectors, just starting out in this line, to follow this advice: crack off a fresh chip from every weathered rock in your vicinity, with the expectations of making a find, and it will be a very hard person to please that does not find something interesting, even if not pretty.

With the idea that one has formed a collection thus, we shall find on examination his fancy to have inclined to rocks of a certain species. The hundreds of curious stones one collects while at the beach, or the various mantel ornaments to be found in almost every house, are specimens that could be classified under one group. Select the most showy specimens from a large collection, and they will generally come under the head of quartz; frequently the larger collections will have nothing left outside of this division.

There is something attractive about all varieties of quartz, or its silicates, that most other species lack, to the casual observer.

A quartz in the gangue, placed beside a diamond in its matrix, will be, when submitted to examination to one not knowing the difference in value, pronounced to be the prettiest.

We find quartz at every step we take; the ocean is full of it, so much so that a type of animalcule was generated to absorb the excess. There we find beds, often hundreds of feet in thickness, that are composed of minute silicious skeletons, only to be seen under a powerful magnifier; yet these little atoms exhibit a beautiful, delicate structure, perfect in all its details. Five thousand placed side by side would not measure an inch. It is to the efforts of a species of these animals that our sponges are produced, and it is at this point that silica is on the boundary of the organic from the inorganic world.

The juices of plants often contain silica; among the raphides, as such mineral crystallizations are called, these forms often resemble anchors, stars, and other forms. One of the purest forms of silica we have, and it is of more use in analyses requiring the use of silica than the pure rock crystal, is a silicious secretion found in the joints of bamboo, and known as Indian tabasheer.

Under the species number 231 (Dana), we find quartz described as occurring massive and crystalline. When crystalline, its form is rhombohedral, or tetragonal to the hexagonal prism; generally defined as a hexagonal prism terminated by a six-sided pyramid. The number of forms it has thus far been noticed in is over 175. A perfectly regular crystal has a taint of rarity about it, and on seeing a crystal for the first time, a person imagines it to be a piece of polished glass. Quartz occurs as short, long, twisted, cruciform, or radiating crystals, and twins; is quite devoid of fracture, yet a tendency may be seen by plunging a heated crystal into cold water. However, I recently examined a piece of clear quartz from Japan, which will be spoken of further on, that had a perfect cleavage. Its fracture is conchoidal. Quartz, when pure, is colorless, but it occurs in every shade conceivable, and, when massive, it may be coarse or fine granular, flinty, mamillary, stalactitic, or concretionary. Luster is vitreous, resinous, or greasy; splendent to nearly dull. Transparent, translucent, or opaque; tough, brittle, or friable.

Quartz is an oxide of the metalloid *silicon*. Silicon is a silvery looking element, never occurs free in nature, and is only with difficulty prepared on a small scale for mere examination. I have before me a fine crystallized piece which requires a microscope to show its form. Even to the advanced collector, the idea of this silvery metalloid uniting with twice its weight of an invisible gas, to form pure silica or quartz, is quite difficult to realize. Its formula is thus SiO_2, and is the only oxide of this element, and its only combination that occurs free in nature.

The varieties of quartz come under two divisions, viz.:

Phenocrystalline, or vitreous.

Cryptocrystalline, or flint-like.

Considering the phenocrystalline, or hyaline quartz, we have quartz crystal or simply masses of clear quartz. As before stated, the crystals are hexagonal prisms, the primative form being rhombohedron. Frequently the dodecahedral form is common, where the two pyramids meet base to base. The Antwerp and Herkimer crystals are of this style. The Arkansas crystals are mostly elongated prisms, occurring in clusters. The Herkimer crystals are rightly termed brilliants, as some are exceedingly bright. They occur in a limestone bed, often associated with or inclosing carbon, and at times a liquid drop so as to move as a spirit level. At times the groupings are very unique; one in my possession is composed of seven doubly terminated crystals joined together by their alternate faces and points touching each other. A collector of experience said upon seeing a lot of these crystals, "I never knew what quartz was before." The Arkansas quartz is world-famed, and occurs in large, showy clusters; but for a tinted quartz nothing can excel the crystals from Mt. Blanc, Cararra, and Switzerland. Crystals have been found weighing over half a ton, and one from Vermont weighing 175 pounds. I would say in regard to the Herkimer crystals that about $3,000 worth are annually sold; many are mounted uncut and sold to tourists under the name of "Lake George brilliants." The sale of the Arkansas uncut crystals amounts yearly to $10,000. At Hot Springs the rolled pebbles called quartz diamonds are more prized than crystals for cutting gems, and are very hard to obtain, they having had such a demand. Powell says that to supply the demand some dealers have produced pebbles by putting a lot of crystals in a box with damp emery, and the box made to revolve several days by power. Large masses of clear quartz are found in North Carolina, but is not much used, as the Brazilian is delivered cheaper, though being in a regular line from Brazil to Oberstein.

Several varieties of quartz crystals are valuable as cabinet specimens, as, for instance, the phantom crystals, that contain a dim but perfect outline of a crystal inside. Another singular and rare variety is what we call "capped quartz." One in my possession is a beautiful crystal that has a perfect cap, which is simply a six-sided pyramid, forming a cover to the end of the crystal. This is due to a cessation in the formation of the crystal, and a thin layer of micaceous clay deposited over it; when the crystal-forming again took place, the clay, of course, furnished no adhesive surface, so on taking hold of the upper crystal the lower one fell out, and the former has since acted as a movable cap.

Hyaline, or clear quartz, has in the last century quite run out of style, the artificial silicate having, to great advantage, taken its place. Formerly hyaline quartz played an important part in the luxurious arts. Mangin says that a lady once gave for a bowl formed of pure crystal, to be used as her private drinking cup, $5,000. Nero, in his last hours, when no hope of empire or safety remained, dashed into fragments two deep goblets of crystal, that they might never be profaned by meaner lips.

The story of Vedius Collio is well known; how he condemned a boy, who had broken a crystal vase, to be flung alive into his lamprey pond; and how Augustus punished him by ordering all vases of the kind to be destroyed in his presence, and the pond to be filled up. In the days of the Lower Empire the wealthy wore solid rings of quartz, and ladies carried balls of crystal in their hands as a solace and a protection during summer heats. King quotes from the Greek:

"Now courts the breeze with peacock feathers fanned,
And now with ball of crystal cools her hand."

Mirrors, burning glasses, and engraved book covers were formed from crystal. We read of a crystal urn, nine inches in diameter and nine in height, on a crystal pedestal, finely engraved, being worth half a million dollars. The crystals containing drops of water were found then, as now, and were regarded as a miracle, giving rise to the idea of having been formed of ice.

In the present day, that art of sculpture in crystal has nearly died out, yet it is in use by opticians, who make lenses and instruments; and a few rich ornaments will always be in market to satisfy the tastes of those who can afford them.

Crystal balls, one of the masterpieces of lapidary work, are of antique origin, but have for the last two centuries been confined to Japan for the most perfect specimens of workmanship.—*Tidings from Nature.*

THE CHEMISTRY OF SULPHITE OF SODA.

By A. BOAKE & Co.

As the chemistry of sulphite of soda and the study of the compounds of sulphurous acid have been pursued with close application in our laboratories at Stratford, the following observations may prove interesting.

Estimation of Sulphite of Soda.—The method followed in our laboratories is the volumetric one, based upon the reaction between iodine and sulphurous acid.

Standard Solution of Iodine.—In preparing the standard solution of iodine, we employ the pure resublimed iodine of commerce, numerous experiments having shown us that it is so nearly chemically pure as to answer all technical requirements; thus the troublesome process of purifying the iodine is dispensed with.

Of the above mentioned iodine, 12·7 grammes (195·99 grains) are weighed out, transferred to a liter flask, covered with about 100 c. c. of cold distilled water, and to this about 25 grammes (385·8 grains) of iodide of potassium are added. Complete solution of the iodine in the iodide of potassium is the object aimed at, and to assist in this, the flask should be rotated so as to agitate the contents. As the solution proceeds, more water is to be added, in portions of about 100 c. c. at a time; finally, when the iodine is completely dissolved, the volume is made up to the mark. If the whole of the water were added at first, complete solution of the iodine could hardly be effected.

Standard Solution of Hyposulphite of Soda.—In addition to the standard solution of iodine, a solution of hyposulphite of soda of such a strength that 1 c. c. of it shall exactly discharge the color of 1 c. c. of the standard iodine is requisite. Recrystallized hyposulphite of soda (easily obtained in commerce) is powdered and spread out in a thin layer upon filter paper. In a moderately dry room at the ordinary temperature, a few hours' exposure upon filter paper is sufficient to eliminate the surplus moisture always present in the hyposulphite. (*Note.*—The hyposulphite must not be dried by heating.) Of the salt so prepared, 24·8 grammes (379·63 grains) are weighed out, transferred to a liter flask, dissolved in a little distilled water, 10 grammes of pure bicarbonate of potash added, and when the last salt is dissolved, the volume made to 1 liter. The object of adding the bicarbonate of potash is to prevent the hyposulphite decomposing. So prepared, the solution will keep for months in a *dark* cupboard without change. The standard iodine, prepared as we have recommended, will also keep for many months unaltered.

Starch Paste Solution.—1 gramme (15·4 grains) of starch is mixed into a paste with a little cold distilled water; 100 c. c. of water, quite boiling, is then poured upon the paste, with stirring. After cooling, the solution is ready for use.

The Actual Assay.—Weigh out 0·5 gramme (7·71 grains) of the sulphite to be tested on a watch glass (the sample should be reduced to fine powder in a mortar previous to weighing). Into a wide beaker or dish 41 c. c. of the standard iodine is run from a burette. The watch glass containing the weighed sulphite is now placed in the beaker containing the iodine solution, and the whole stirred with a glass rod until the sulphite is completely dissolved, which takes place almost immediately. The amount of iodine solution employed, viz., 41 c. c., being a little more than the quantity actually required by 0·5 gramme of pure sulphite of soda, there will necessarily be an excess of iodine remaining in the beaker after the above operation is concluded; this excess is measured by running in the standard hyposulphite of soda already mentioned, drop by drop, from a burette. As the excess of the iodine is consumed by the standard hyposulphite, the color of the solution becomes lighter. When the color is only faintly yellow, a little starch paste is added, when the deep blue coloration of iodide of starch appears, and renders the end of the reaction more delicate. After adding the starch paste, continue to drop the hyposulphite in, stirring between each addition. When the end is reached (*i. e.*, when the excess of iodine is completely consumed by the hypo), the blue color of the iodide of starch is lost, the fluid becoming colorless. Now read off the number of c. c. of hyposulphite employed, deduct this quantity from the 41 c. c. of iodine run into the beaker, and the remainder will be the iodine consumed by the 0·5 gramme of sulphite of soda weighed out. To obtain from this the percentage of crystallized sulphite of soda ($Na_2SO_3 7H_2O$) in the sample, multiply the number of c. c. of iodine consumed by 2·52 (we suppose 0·5 gramme of sulphite of soda to be used for the estimation).

Example.—0·5 gramme sulphite weighed out, transferred into 41 c. c. of iodine, required 2·1 c. c. of hyposulphite to discharge excess of iodine; therefore 41 c. c. —2·1 = 38·9, and 38·9 × 2·52 = 97·03 (percentage of crystallized sulphite of soda present in sample).

The above modification of the iodimetric estimation of the sulphites was fully described by Messrs. Giles and Shearer in a paper read before the Society of Chemical Industry (*Soc. Chem. Ind. Journ.*, May, 1884), where the authors pointed out that the plan of dissolving the sulphites in water previous to titration led to low results. In addition to the error due to the above, the procedure of running in the iodine into the sulphite tends to an error in the same direction.

The rapid deterioration of sulphite only applies, however, to the low quality sulphite of foreign (German) manufacture. We have frequently analyzed samples from the source named containing no more than 50 per cent. of $Na_2SO_3 7H_2O$. As the largest makers of pure sulphite of soda in the world, we can state that a commercially pure salt containing 98 per cent. of sulphite, as sent out by us, will keep for any length of time in a well-corked or stoppered bottle without undergoing any practical change.

It should be mentioned that low quality sulphites, in addition to other impurities, are always contaminated —frequently very grossly so—with hyposulphites, thus rendering them most objectionable for use in the developer.

The presence of hyposulphites in sulphites is easily detected by dissolving a quantity of the sample (two or three grammes) in distilled water, adding a considerable excess of hydrochloric acid, say 40 c. c., and boiling for ten minutes; the presence of hyposulphites is indicated by the fluid becoming turbid from the separation of finely divided sulphur. The testing for sulphates requires more care than is generally supposed. If no sulphate were orginally present in the sulphite, it would certainly be formed by the action of the oxygen of the air, unless precautions were taken to exclude the latter, when the sulphite is brought into solution in presence of hydrochloric acid. The examination for sulphates should be conducted as follows: A small flask of about 200 c. c. capacity is fitted with an India-rubber stopper, the latter being pierced so as to carry a short length of glass-tubing, drawn out to a fine point at one end. Into this flask about 100 c. c. of distilled water and 20 c. c. of hydrochloric acid (free from sulphuric acid) are placed; the stopper, with drawn-out exit tube inserted, is placed over a lamp, and the contents briskly boiled for ten minutes, when the stopper is momentarily removed, about a grm. of the sulphite dropped in and the stopper replaced. The boiling is continued until the whole of the sulphurous acid is expelled; fifteen minutes' boiling will usually be sufficient to attain this. The solution, free from sulphurous acid, may now be tested for sulphuric acid by means of chloride of barium solution; only a slight cloud should make its appearance upon dropping in the $BaCl_2$ if the sample is a good one.

From the character of the sulphites, the method of analysis employed, while not necessarily demanding a great expenditure of time, requires to be based upon thoroughly sound principles in order that results of technical value may be obtained.—*Photo. News.*

A NINEVEH WHEEL.

LONG ISLAND CITY, N. Y., December 7, 1885.

MR. EDITOR: Through the kindness of Henry T. Drowne, Esq. (a member), it was my pleasure to visit the museum of the society, Second avenue, corner of East 11th street. Among the many relics and curios on exhibition at the Historical Society Rooms of New York is a chariot-wheel exhumed from a mummy-pit near Dashour, Egypt, by Dr. Abbott. The wheel, it is supposed, was made more than 2,000 years B. C., which would consequently make the wheel 4,000 or more years old at present.

In appearance, the wheel would compare with the

ordinary wheelbarrow wheel of to-day, only much larger. Owing to the wheel being inclosed in a case, it was impossible to arrive at correct measurement. The hub is about 18 inches long, the swell at the center is about 6 inches long and about 6 inches diameter, the outer ends are about 6 inches long each, and about 4 inches diameter. In all there are 6 spokes, a wood rim and a tire of the same material, over all measuring about 40 inches.

The size or caliber of the spokes, rim, and tire is in proportion to the hub, and well calculated to have borne any strain or weight the hub was competent to carry.

The tenons of each spoke are nearly square, and inserted in square mortises at hub and rim. Near where the spoke enters the rim is a sort of blank scroll, which, I take it, has been intended for ornamentation.

Near the hub each spoke has a duplex mortise. One portion of the mortise is vertical; the other portion is horizontal, or at right angles with the vertical mortise, the whole resembling in shape a black letter T.

The rim is in six pieces, and forms a splice-joint over the end of each spoke, the spoke passing through both pieces. From the checks in the rim, I take it that the same has been made of wood indigenous to lowlands, and from a tree with a natural bend, but not sufficient to form the circle. The balance of the bending has been by artificial means.

The tire seems to have been bent wholly by artificial means. It also is in six pieces, and furnished, each section, with four mortises, equidistant, near its inner circumference. While I could not see the ends of the sections of the tire, they being at present secured by iron plates, I take it for granted that the same have been doweled together.

This explains the skeleton on exhibition. I will now proceed to put the wheel together. After the spokes have been driven into the hub, the horizontal mortise in the spokes has been filled with a strip of bent wood and joined at the center of the mortise. Next the vertical mortise has also been filled with another strip sawed or bent and joined at the spoke the same as the horizontal piece, the two pieces forming a union and resembling the T iron of to-day, and thus giving the greatest possible amount of strength, for the purpose hereafter described. The rim has next been placed on the spokes. Then the tire has been fitted, with the joints over the spoke, with a view to prevent the "caving in" of the rim.

Now we arrive at the uses of the inner rim and mortises in the tire. The tire has been secured to the rim at the two central mortises in each section by means of rawhide or cordage. The rim and tire, in order to gain additional security, are, at the end mortises of each section of the rim, secured to the inner rim by the same material used in securing the tire to the rim. It is possible that the longer lacings may have been bound to the spoke at the blank scroll, and in such a manner as to take up any slack of the longer lacing; and thus we have the wheel complete.—*J. L. H. Mosier, in Carriage Monthly.*

PROPERTIES OF ZINC.

THE author undertook to inquire if zinc free from any foreign metals decomposes water either on boiling or in presence of dilute sulphuric acid. Experiment proved that such is not the case. Pure zinc heated with distilled water in a flask, so arranged as to receive the gases over mercury, gave off no hydrogen on prolonged boiling. It was also not attacked by dilute sulphuric acid. The presence of iron in proportions of from 3 to 5 in 100,000 enabled it to decompose water. Traces of arsenic and antimony have the same effect.—*L. L'Hote in Comptes Rendus.*

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